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POWER

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Steam from Electricity

SEVERAL letters called out by articles on electrical boilers evidence apprehension that the all-invading electrical service threatens even the boiler room.

Like much of the other apprehension regarding electricity, which has done more than anything else to increase the amount of power produced from fuel and to multiply the opportunities of the steam engineer, this apprehension is groundless.

A pound of good coal has something like four times as much heat-producing capacity in it as a kilowatt-hour and costs about a quarter of a cent.

Taking into account all the advantages of electricity in efficiency of conversion, lack of handling and stoking costs, ash disposal, etc., it is evident that electricity can be used for generating steam only when it can be had at a cost below that of its usual production.

The best of the electric stations can hardly make a kilowatt-hour with a pound of coal, and the pound of coal burned under a boiler would generate three times as much steam as would a kilowatt-hour of current fed into it.

One may as well fear that all the power will be produced hydraulically because they are running hydro-electric stations with water pumped back over the dam.

Just as it is profitable to make water that would otherwise run to waste pump some of itself back into the mill-pond for use when there is a demand for it, so it may be profitable to apply to the making of steam electricity generated by water that would otherwise be lost or that for some other reason can be very cheaply produced.

There are doubtless occasions and applications where the cost per unit of heat is not the controlling factor. I know of a case in a paper mill where economies were effected by laying off the night crew in the boiler room and supplying the night demand by steam generated by electricity from the company's own hydraulic plant.

Its greater cleanliness, convenience and controllability make electricity the ideal method of applying heat in moderate quantities for many purposes. It is used quite extensively for cooking and to some extent for domestic heating and such applications are bound to grow in number and extent.

But there will have to be a big improvement in the process of converting fuel into electricity before electricity can, in other than exceptional cases and in limited amounts, take the place of fuel.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Less Waste in Transmission and Application

POWER supply is just as important as the production machines that use it. If the power fails the production process is interrupted just as surely as when the machine breaks down. Not only that—unnecessary losses allowed in supplying power to production machines are equivalent to inefficiency in the manufacturing process.

Failure to give proper attention to the power supply may lead to even more costly breakdowns than the neglect of manufacturing equipment. If a manufacturing machine fails, it is not likely to tie up the whole works, but a fault in the power system may easily do this. No matter from what angle the power supply is considered, it will be found to affect vitally the economy of production. Therefore power equipment should be selected with as much care as production machines.

Direct motor drive has come into prominence. The small space required, the absence of belts or gears and other accessories make it attractive. But such drives are not always feasible and, even when they are, they may not prove to be the most economical. In the final analysis the unit production cost should be the guide. This means considering the whole manufacturing process as a unit, from the coal pile to the finished product.

Slow-speed alternating-current induction motors have a lower efficiency and a lower power factor than high-speed motors. With direct-current motors the efficiency only has to be considered. The low power factor of slow-speed induction motors may be more objectionable than low efficiency and increase the power cost an equal or greater amount.

These conditions give the high-speed induction motor with some form of speed reducer for slow-speed drives an advantage over the slow-speed motor directly connected. As indicated in the first article in this issue, short-center belt drives of various types are used extensively for such services. For a wide variety of applications these will prove the most economical. But in their selection, as is true with any other type, careful consideration should be given to all factors involved.

Research Activities Increase

NOT long ago a speaker characterized research as "the lifeblood of industry." Many fields have recognized this for some years past, but it is only recently that power engineers have seen the light. Short, however, as is time during which organized research has had the support of the power field, a great amount has already been accomplished and projects now under way hold forth much promise.

Foremost in the field are the activities of the American Society of Mechanical Engineers. This society carries on its research activities under the guidance of a main research committee, with special research committees for individual projects and research survey committees from the professional divisions for determining the need for new projects.

There are twenty of these special research committees, some being joint committees co-operating with other organizations. Five new committees were authorized by the society, of which those dealing with Diesel fuel oil, wire rope, and absorption of radiant heat in boiler furnaces are of particular interest to the power field. Committees previously established deal with lubrication, fluid meters, properties of steam and extension of the steam tables, elevator safeties, effect of temperature on the properties of metals, boiler feed water, condenser tubes, boiler-furnace refractories, welding of pressure vessels, velocity measurement of fluid flow, fuels, and the physical constants of refrigerants.

Much of value in the continued progress of the generation and utilization of power will undoubtedly come from these researches. But the work will not bear its full fruit unless all power engineers contribute what they can of knowledge, time and money to the effort. Just as the industrial research carried out by the equipment manufacturers needs the co-operation of power engineers if the best possible equipment is to result, so does fundamental research need their help. Let all put their shoulders to the wheel.

"Impractical"— Where Does the Word Belong?

IT HAS been said many times that the scientist withdraws himself behind an impenetrable barrier to play with abstruse theories and outlandish jumbles of wires and chemicals, producing nothing of value to you and me. The world does not believe in this idea quite so much today as it used to. The public mind has swung through a cycle; from fear and worship of the medieval alchemist and magician it has passed successively through contempt, indifference and tolerance and is beginning to be decidedly appreciative of what the scientists are doing. But the word "impractical" has been thrown at the theorist for so long that it is still the habit of the lay mind to use it. The word is applied to the wrong man. The chap who thinks the world is flat and spends a lifetime proving it; the well-intentioned crank who devotes his days to a perpetual motion machine that will give the

world "free"power—these are the men that deserve the epithet impractical.

Words, like everything else, are relative. The scientist is impractical to many simply because his work is not obviously traceable to machines that run. That is not his fault, of course, but the fault of those unable or unwilling to trace the steps that lead from theory to practice.

If public interest were centered in the scientific man a little more and if less credit in proportion were given to the fellow who translates the scientist's ideas, we should all be doing a better job of co-operation and be helping to shift the word "impractical" to the shoulders that deserve to carry it.

Unbalanced Technical Education Threatens National Progress

"IF I had only three thousand dollars in XYZ stock back in nineteen eight, I'd be worth a million today." Such exclamations as this, commonly heard in speculative circles, keep one from forgetting the connection between the individual's present decisions and his future prosperity.

Nations, similarly, make their educational investments today, and ten, twenty or fifty years hence will reap harvests that will measure their present judgment. No clear-eyed observer can question the enormous part technical education has played in the development of industrial America. The future effects of present-day technical education will be even more profound.

This being true, critical study of our system of technical education becomes a major patriotic duty. Fortunately, the different educational policies of the world's leading nations during the last century makes possible a comparative study of the utmost value. We can learn as much, or more, from the educational successes and mistakes of other countries as from our own.

In this connection a note of real importance is sounded by W. E. Wickenden, director of investigations, Society for the Promotion of Engineering Education, who asks, in this issue, "Where Are We Headed in Technical Education?" As Mr. Wickenden points out, the educational history of England, France, Germany and the United States proves that neither a central bureaucracy on the one hand, nor individual and local initiative on the other, is a safe guide of a nation's industrial destiny. Great Britain lost fifty years of her early lead over Germany because, before 1880, she depended almost entirely on private and local enterprise. From 1840 to 1890 France allowed bureaucratic red tape and narrow vision to stifle her system of technical education. She, too, suffered great industrial losses as a result. In Germany the *Verein Deutscher Ingenieure* must be credited with creating and sustaining the broad national conception of technical education that has made Germany, next to the United States, the world's greatest industrial nation.

American technical education, according to Mr. Wickenden, has done a fine job in the professional training of engineers, but has failed to provide properly for the great number of junior technicians who must carry out the plans of the highly trained minority.

This problem cannot be left to the initiative of industrial schools, which are wrapped up in their local problems. Nor can government or industry be depended on for the initiation and carrying out of a well-balanced national program of technical education. The task must apparently fall on some agency that is independent but closely in touch with the schools on the one hand and with the engineering societies and industry on the other.

Perhaps, as Mr. Wickenden suggests, the S.P.E.E. is the best existing nucleus for such an agency. At any rate, it is clear that national industrial progress demands broadly integrated promotion of a balanced scheme of technical education and that this must provide for followers as well as leaders.

Individual Power Plants May Be the Solution of the Submetering Quarrel

JUST now the owners of New York City buildings are deep in a struggle to maintain the existing submetering system. Each side of the controversy now before the Public Service Commission, concededly has certain points in its favor.

The broad-minded progressive building manager recognizes that there is no logical ground for his purchase of electricity at wholesale rates, to be sold at retail to the tenants of his building. Beyond the small extra expense of meter reading and book-keeping, there is no reason for a rate structure that gives the buyer of a large quantity of power a lower rate than is obtained by the user of a small quantity, as long as the load factors are identical. However, as long as the public-service companies build such illogical rate structures, a building owner cannot be blamed for desiring all possible benefits.

The case of the public-service company is somewhat weakened by the fact that in past years it encouraged submetering. In the effort to build up a load in office buildings, hotels and large apartment houses, the owner was shown that submetering gave him all the advantages he could obtain from his own individual plant, without a capital investment. As a consequence most of the new buildings have been erected without generating plants, the owners depending upon a continuation of the submetering arrangement.

If submetering is ordered discontinued, the building man's situation need not be uncomfortable. If a large building is now equipped with high-pressure boilers, a generating plant can be installed and power can be developed at a cost lower than the retail rate. Even if the boilers are low-pressure the case is not desperate, for Diesel engines can be slipped in with the minimum of alteration expense.

Under almost any conditions the building owner can generate power and distribute it to his tenants at a profit.

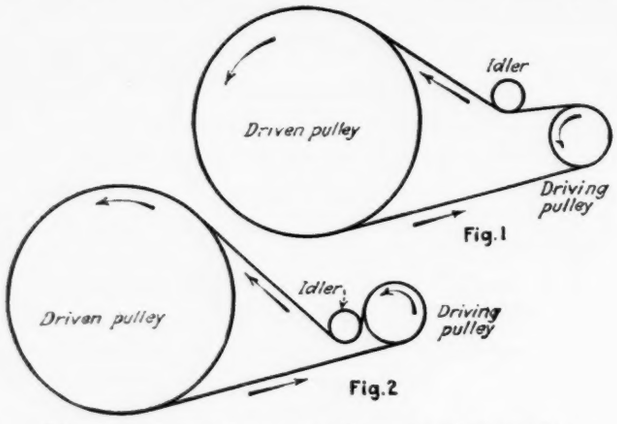
SHORT-CENTER DRIVES

Made Effective

by idlers located to increase the belt's contact arc on the pulleys; by increasing the belt's coefficient of friction; by V-shaped belts running in grooved sheaves

By B. A. Briggs

DRIVE SHAFTS on many machines operate at speeds that allow connecting motors directly. When this can be done and a comparatively high-speed motor used, it is a preferred type of drive. There are applications where directly connected slow-speed



Figs. 1 and 2—Wrong location and right location of idler on belt

motors have advantages over other types of drive, but these are exceptions and not the rule. Where a slow-speed drive shaft is required, a comparatively high-speed motor with some form of speed reducer is generally the most economical.

This arrangement allows using motors having smaller dimensions, lower first cost and higher efficiency than slow-speed designs. The power factor of a high-speed induction motor is higher than that of a slow-speed motor. This feature is in favor of using the high-speed induction motors, both when power is generated in a private plant and when it is purchased.

A belt driving from a small pulley on the motor to a large pulley on the driven machine is a common type of speed reducer. When a belt is properly installed and maintained, it provides an efficient method of transmitting power short distances. Conditions under which belts have to operate frequently affect their efficiency adversely.

Long center distance between pulleys with the slack side of the belt on top is generally the ideal condition. A long belt is more elastic than a short one and can operate with a minimum tension. When load is applied, the belt stretch is transferred to the slack side. The top side of the belt becoming more slack, increases its sag and arc of contact with the pulleys. This in turn increases the friction of the belt on the pulleys and improves the power transmitting qualities of the drive.

When belts are used on short-center drives, their arc of contact with the small pulley is reduced compared with

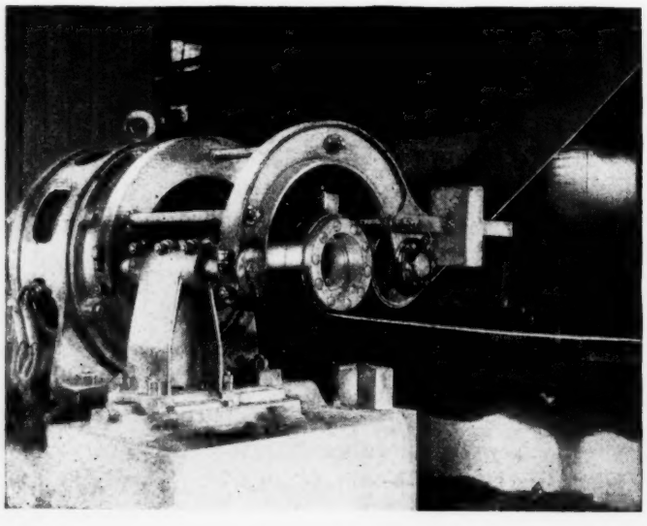


Fig. 3 — Induction motor and Lenix drive, rated at 100 hp., driving a brick-plant auger machine

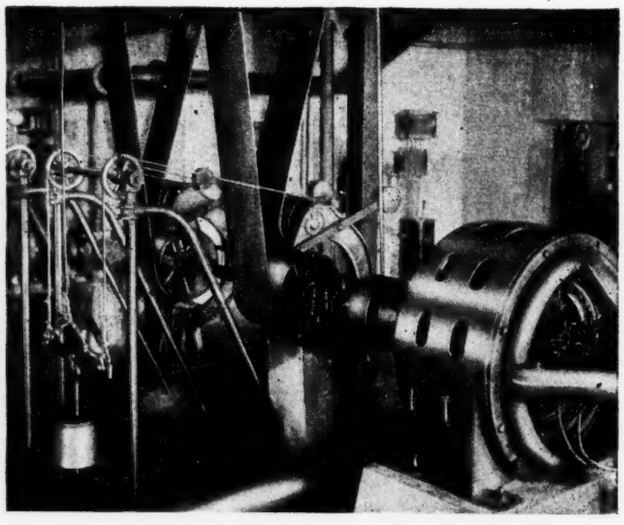


Fig. 4—Vertical Lenix drives connect paper-mill beaters to motor-driven lineshaft

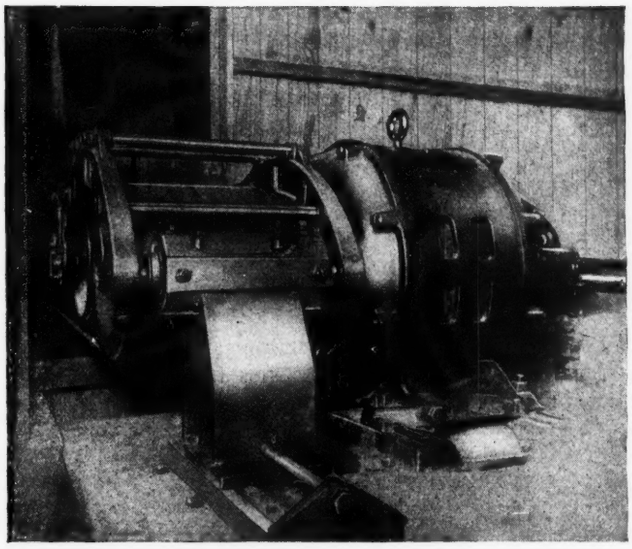


Fig. 5—Pulmax drive operating jaw crusher; pulleys 20- and 84-in. diameter on 96-in. centers

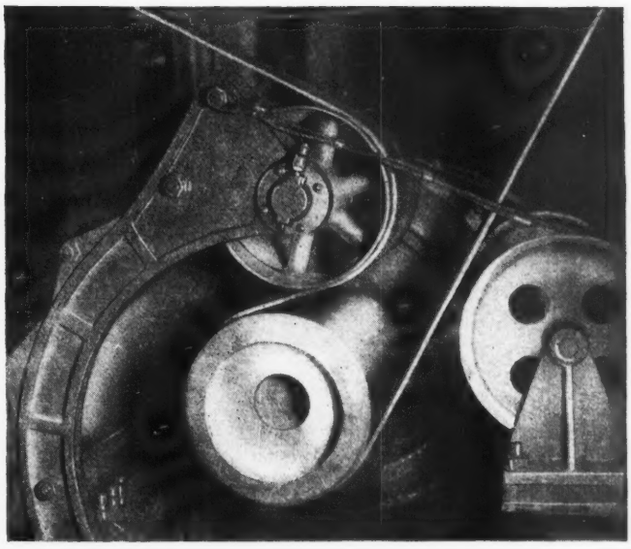


Fig. 6—Pulmax drive operating 120-kw. generator; pulleys 16- and 100-in. diameter on 84-in. centers

long-center drives having the same pulley ratio. This makes it necessary to operate the ordinary open drive with a greater tension in the belt. The belt being shorter and less elastic, does not allow the increased arc of contact under load obtained with long-center drives. Even when pulleys have equal diameters, open short-center belt power-transmitting qualities fall off rapidly compared to long-center belt drives.

Tests were made by the Leather Belting Exchange Foundation, on a four-inch single-leather belt, with the tight side on the top, running on 24-in. pulleys. These showed that beyond a certain per cent slip the power of the short-center belt falls off rapidly. For example, at 2.5 per cent slip and the pulleys on five-foot centers, the belt transmitted about 37 hp. When the pulleys were placed on twenty-foot centers, the belt, with 2.5 per cent slip, transmitted 70 hp. Increasing the load on the long-center belt produced only a normal increase in the slip, indicating that the maximum capacity of the belt had not been reached. Beyond 37-hp. load on the short-center drive slip increased rapidly, which showed the maximum capacity of the belt had been reached. The same static tension was maintained in the belt for each test.

Increasing the tension of the belt to maintain its power-transmitting qualities is unsatisfactory. It reduces the belt's life, decreases the drive's efficiency, makes proper bearing lubrication difficult if not impossible, increases bearing wear, causes excessive bearing temperatures, puts undue strain on machine parts and increases power consumption.

Efforts to overcome these objections to short-center belt drive and obtain its advantages have led to a number of developments. These in general may be included under two heads, a means of increasing the belt's arc of contact on the pulleys and increasing the belt's adhesion to the pulley. The former method is a scientific development of the old idler or tightener pulley.

The old method of applying idlers to a belt was in many cases nothing better than a means of increasing the tension. In this the idler was applied something as shown in Fig. 1. Such an idler puts a maximum tension in the belt, but causes a minimum increase in arc con-

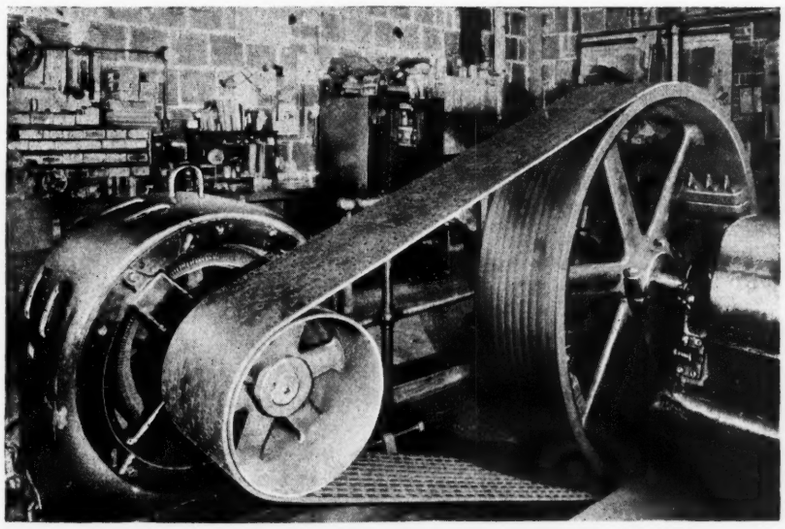


Fig. 7—Motor, 125 hp., connected by Tentacular belt to air compressor, pulley diameters 18 and 74 in. on 72-in. centers

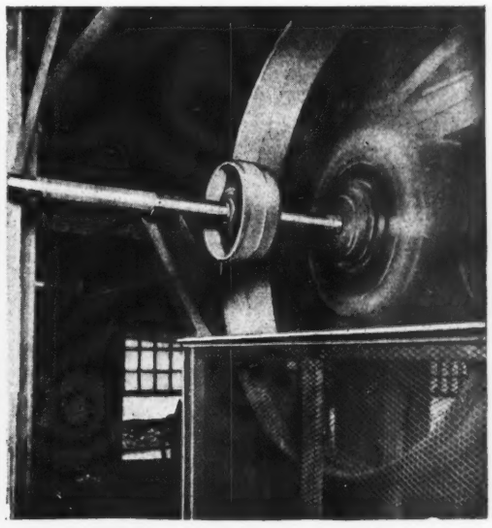


Fig. 8—Tentacular belt connects 12-hp. motor with 7-in. pulley to 90-in. pulley

tact on the small pulley. With the idler located as in Fig. 2, it produces a maximum contact arc with the pulley and a minimum tension in the belt for a given weight of idler. This is the principle involved in modern short-center belt drives, good examples of which are shown in Figs. 3 to 6. The idler, as in Fig. 3, is fulcrumed so that any increased slack in the belt is wrapped around the small pulley to increase the arc of contact. In other words, as the load is increased on the belt its arc of contact with the small pulley is increased. This allows transmitting a given load with a minimum tension in the belt, the idler being counterweighted to obtain this tension. These idlers are applied to horizontal belts with the slack side on the top or on the bottom, also to vertical belts as shown in Figs. 4 and 6.

This system puts a sharp reverse bend in the belt as it runs over the small pulley and idler. If the belt is made endless, this bending is not detrimental to its life. Metallic fasteners should not be used in belts for these applications.

These drives are used for capacities up to 1,500 hp. and for pulley ratios up to 10 to 1. In this country belt speeds up to 8,000 ft. per min. have been used, but 10,000 ft. per min. has been used in Europe. For the higher speeds steel-rimmed pulleys are required, which must be very carefully balanced.

In the application, Fig. 4, the motor is coupled to a lineshaft from which several paper-mill beaters are driven. Provisions are made to start and stop the beaters at will by applying the idlers to or releasing them from the belts.

In another application, connecting a waterwheel to a generator, the idler was applied to a quarter-turn belt rated at 200 hp. The belt speed in this case was 5,660 ft. per min. and the pulley diameters were 30 and 24 inches.

As previously mentioned, another way of increasing short-center belt capacities, without excessive tension and slip, is to increase their friction on the pulley. The old way of doing this was to apply a sticky dressing to the running side of the belt. Such dressings injure the belt and require frequent applications to prevent slipping. These dressings are usually applied only when slipping cannot be prevented by increasing the belt's tension. As a consequence, most short-center belts operating under these conditions have excessive tension, which is objectionable for the reasons previously outlined. If these objections are to be avoided, it is necessary to use an automatic idler with the common forms of belting, as in Figs. 3 to 6, or use a belt designed to have practically a permanent high coefficient of friction.

Applications of the latter are shown in Figs. 7 and 8. The backing of this belt is made of high-grade oak-tanned leather or of Balata, which is made of tightly woven heavy cotton duck, thoroughly impregnated with a gum called Balata. These two classes of belting have high tensile strength, which insures a minimum of stretch. On the pulley side of the belt narrow longitudinal strips of soft green leather are attached. This leather is made by a special chrome tanning process, which gives it a high coefficient of friction. The strips are held in place by hollow brass rivets that form hemispherical pockets on the belt's running side.

No special equipment is required for this class of belt. Plain cast iron on steel pulleys with a small crown are used. This belt may be applied to almost any kind of drive up to 7,500 ft. per min. It can be used on tight and loose pulley applications and shifted as can standard classes of belting. Crossed-belt applications should be limited to pulley ratios of 5 to 1 or less. Where a certain amount of slip is required, such as on a metal planer with fast and loose pulleys of unequal diameter, this type of belting is not suitable.

Allowable distances between pulley centers are limited by the arc of contact that the belt makes with the small pulley, which should not be less than 135 deg. A 145-

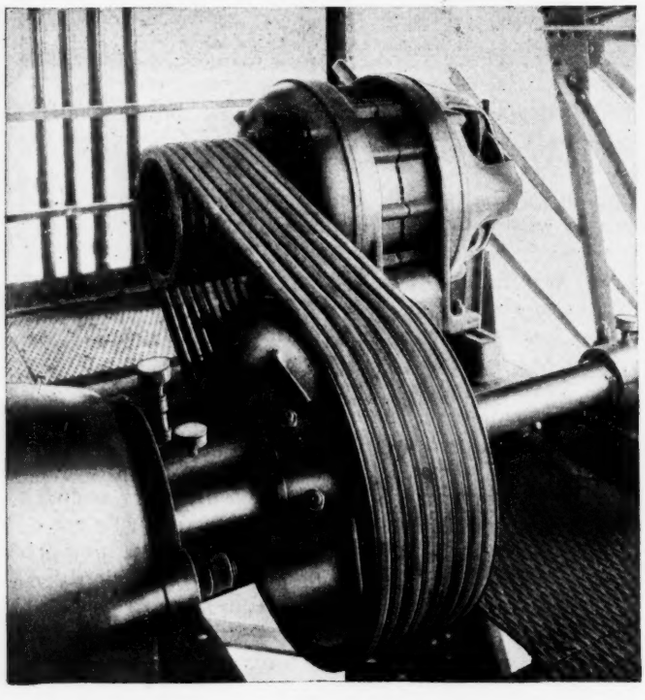


Fig. 9—One of two 100-hp. induction motors and Texrope drives operating ten-inch rock crusher

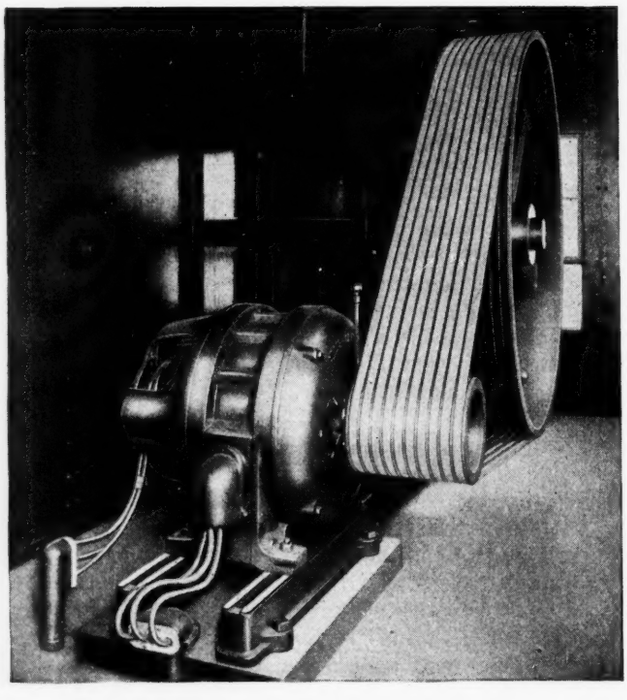


Fig. 10—Induction motor and Texrope drive, rated at 60 hp., operates automatically controlled mine fan

deg. arc of contact is recommended, which, up to four-to-one pulley ratio the distance between pulley centers should not be less than 1.25 times the diameter of the large pulley, and for ten to one ratio 1.5 times the diameter of the large pulley.

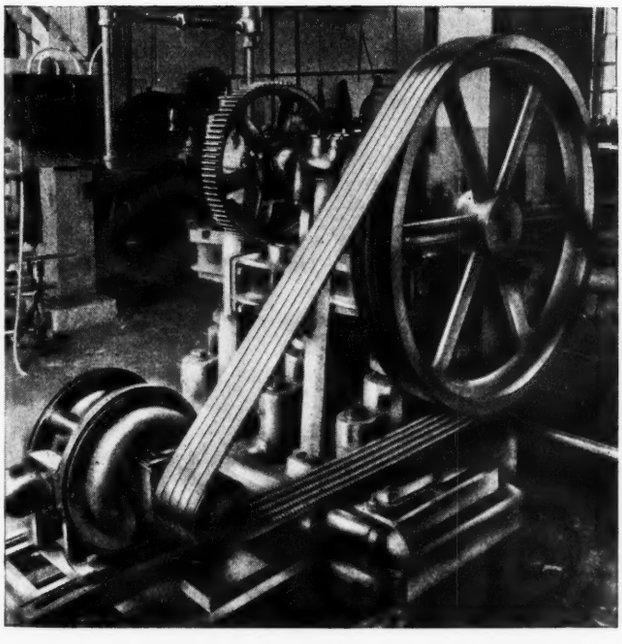
When the belt is exposed to heavy dust, it should be cleaned at given intervals with a fairly smooth wire brush applied to the chrome leather strips. After doing this, dip an ordinary flat brush in hot tallow and spread gently over the strips. If the belt is operating under normal conditions, tallow should be applied only when the pulley's face is quite dry.

Using a trapezoidal rubber and fabric belt running in V-grooved sheaves is another method of obtaining a short-center belt drive, as in Figs. 9 and 10. With this drive the wedging action of the belts in the V grooves is depended upon to transmit the power, therefore the ropes can operate with very little tension in their slack side. The greater the load the greater the wedging action into the sheave's grooves, therefore slip is practically eliminated.

This type of drive was originally designed for the textile industries, but its use has extended into a wide variety of applications, where a short-center drive is required. Being of a multiple construction, there is little danger of a complete failure of the drive. One of the several belts may fail, but the machine can be operated with the remaining belts until it is convenient to make replacements. This drive is quiet in operation, which makes it well adapted to driving fans, in public buildings and other places where noise is objectionable.

This drive can be used for almost any power capacity by increasing the number of belts. Sheave ratios greater than seven to one are not recommended unless the center distance is such as to give a contact arc on the small sheave of 120 deg. or greater. Although these drives are primarily intended for short center, ropes 150 ft. long can be supplied endless. They can be used in any position and with the slack side on the top or the bottom. Belt speeds up to 6,500 ft. per min. are permissible.

Fig. 11—Plunger pump connected to a motor by a Cog-belt drive



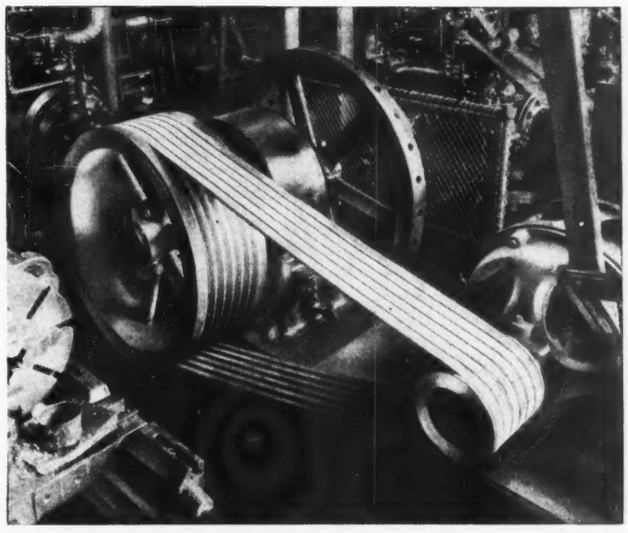


Fig. 12—Motor connected to an air compressor by a Cog-belt drive

Among drives of this kind may be found a 150-hp. installation with sheaves placed on 50-in. centers and a ratio of about three to one. Another is where 65 hp. is transmitted with sheaves having a five-to-one ratio placed on 49-in. centers.

Another type of drive, using belts of trapezoidal cross-section and running in V-shaped grooved sheaves, is shown in Figs. 11 and 12. The belt has a series of tooth-shaped corrugations on its inner surface. This cogged surface is not for the transmission of power, but is to provide flexibility and to prevent buckling when the belt flexes around the pulley. The belt is designed to ride between the sides of the grooves, but never to touch the bottom of the vee. Standard belts of this type have 42-deg. included angles between the driving faces, designed to ride in a 38-deg. groove angle.

It is recommended that not less than $\frac{3}{16}$-in. space be allowed between the bottom of the pulley grooves and the inside surface of the belts. Standard practice requires that the top surface of the belt be slightly above the outside of the pulley. If the top of the belt is slightly above the pulley grooves, there is not the tendency for it to curl and dish as when riding below the top of the grooves. Riding flush may also cause undue wear at the top corners of the belt if the pulleys are not exactly in line, as the wear is concentrated on a small area of the belt's riding surface.

For this type of drive the motor should be mounted on an adjustable base, so that slack due to seating of the belt can be taken up. When applying these belts, average load conditions are assumed to be those where the starting torque is equal to or less than full-load torque and sudden overloads are not encountered. Where starting torques and peak loads exceed 100 per cent of full-load rating but are less than 150 per cent, 25 per cent more belts are recommended than for average conditions. If the starting torque and peak loads exceed 150 per cent full-load value but are less than 200 per cent, 40 per cent more belts are recommended than for the average classification. Reversing applications such as hoists require 25 per cent more belts than the average one-direction drive. Use of an increased number of belts for severe conditions, as indicated in the foregoing, will prevent slippage when starting under peak loads and will increase the life of the belts.

GRAPHIC INSTRUMENTS

Search Out Power Faults

Switchboard-type graphics give permanent record of all plant operations; portable wattmeter saves many times its cost by making a record of abnormal condition existing in individual machine.

By R. S. WERTHEIMER and W. D. RIGGS
Manager *Electrical Engineer*
Longview Fibre Company, Longview, Washington

Graphic wattmeter used to check load on motors

ELECTRIC instruments of the graphic type are used at the new mill of the Longview Fibre Company with substantial operating benefits. The mill manufactures paper and board from fir and hemlock pulp and has modern equipment, including many electric instruments used to check operations and to guide in the expansion of the mill.

This company purchases about 40 per cent of its power and generates the remainder. About 300 motors ranging from one to 450 hp. are supplied with 60-cycle three-phase 440-volt current. About 30 per cent of the connected load is in synchronous motors, and the power factor runs as high as 90 per cent.

The mill has two portable graphic instruments, a wattmeter and a voltmeter, and in addition about 30 graphic switchboard instruments, including two direct-current voltmeters used as tachometers on the paper and board machines, and 28 wattmeters. Ten of the latter are used in the power house on feeders, eight on jordans and ten on beaters. All are General Electric devices.

The portable instruments have chart speeds of one, three, six or twelve inches per minute or per hour and are used to check power input and characteristics of the loads throughout the plant. Starting with the beginning of operation, a systematic check was begun on every motor, but this program has been interrupted. Meanwhile the instruments are being used when individual requirement develops.

The direct-current voltmeters were originally clock-driven, but have been changed to motor drive, and the chart speed changed to three inches per hour. Chart speeds of one inch per hour are now being tried for the purpose of cutting down chart costs. It is believed that the legibility of the chart indications at this slow speed will be satisfactory. They serve as a speed check on the paper or board machines and are considered essential, as changes in speed directly affect the caliper.

The paper machine is a steam-driven unit, and the board machine uses a sectional drive with direct-current motors and voltage regulation. Occasionally, the controls permit a change of a few feet per minute in speed and, although the paper is affected so little as to be unnoticeable to the eye, the periodic field tests show the effect. The result of lowered speed is a loss of material which would represent a considerable amount if allowed to continue for any length of time. Inspection of the tachometer chart gives immediate indication of trouble.

The power-plant wattmeters are used to determine the power requirements of the different departments. The meters on jordans and beaters form a permanent record for the office, indicating the complete time cycle of each operation. In case of a complaint on the product the beater and jordan charts can be referred to in order to fix responsibility.

Use of the instruments has resulted in savings in both power costs and motor maintenance and has also helped to avoid the purchase of new equipment. Several cases will be cited to show specific uses that have been advantageous to operation and maintenance. Savings are large in several cases, exceeding the cost of the instrument used to determine the fault, but cannot be evaluated except in a few instances.

The chart, Fig. 1, gives the record of a test run on a 75-hp. motor driving a chipper handling fir blocks and

running eight hours daily to supply chips for the digester department. This motor overheated and the chipper was frequently stalled by a large block jamming in the machine, delaying production for an hour or more while it was being worked out. The motor was unable to handle the load imposed by the larger block and, although it was 50 per cent larger than the manufacturer had recommended for use with the machine, a test was made to determine whether a larger motor should be used.

The test showed that the average load was 64 kw.,

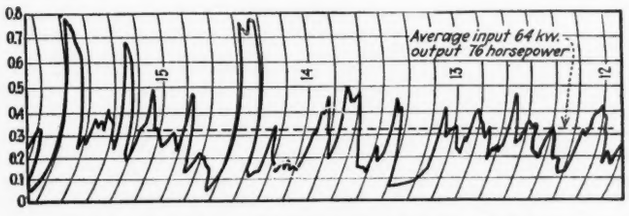


Fig. 1—Load on 75-hp. motor driving chipper

This graph shows that the maximum load on the motor reached 148 kw., which was 230 per cent of the motor's rating. The trouble was overcome by installing a 150-hp. machine.

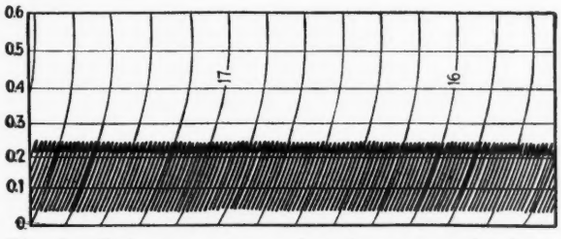


Fig. 2—This chart shows that the average load on a 7½-hp. air-compressor motor was nine to ten horsepower

The air requirements of the process were studied and found to be less than the pump had been delivering. A change in pulley size reduced the compressor speed and load within the capacity of the motor.

which was not an overload, but that at the peaks the load reached 148 kw., which was 230 per cent of rating. It was clear that the trouble could be solved only by installing a larger motor, and one of double the original size was applied. This eliminated both overheating and stalling of the motor.

The saving in this case cannot be evaluated. With only one delay per day it was possible to meet production requirements, but when several occurred or when more than an hour was needed to clean out the chipper, the department was taxed to maintain a supply of raw product for the mill. There was also the potential saving as a result of eliminating the possibility of a burnout caused by continued overload.

Motor Overload on Air Compressor

Fig. 2 shows the load chart on a 7½-hp. motor used to drive an air compressor operated for lime recovery. Continued heating indicated need of a test, which showed an average load of between nine and ten horsepower. Instead of changing the motor, the air requirements of the process were studied and were found to be less than the pump had been delivering. Thus, only a pulley change was needed to reduce the compressor speed and motor load to a level which the motor has since carried without trouble.

Another test was run on two motors, one thought to be too large for its load and the other running hot. The first drove a vapor removal fan on the board machine and was shown to have an average input of 35.2 kw., corresponding to 47 hp. output, or 78 per cent of its 60-hp. rating. The second motor drove a white water pump on the board machine and was found to be carrying a load of 55 hp., although it was rated only 40. These motors were exchanged and now operate at their most efficient loads.

The change effected here resulted in saving the purchase price of a new motor to drive the pump, approximately $300, less salvage on the old. It was clear from the condition of the motor that it was overloaded, but without the meter the exchange would hardly have been attempted.

A different and rather more interesting use of the wattmeter is shown by the chart, Fig. 3, which gives the cycle of operation on a fifteen-horsepower motor driving a Morterud pump on a digester, which was subject to occasional burn-outs for reasons not at all clear.

The pump serves a double purpose. After chips are placed in the digester, the pump forces cooking liquor into the digester for from five to fifteen minutes, subjecting the motor to a 50 per cent overload, but for a period so short as not to be injurious. The second part of the cycle follows after a few minutes, the liquor being circulated for one to one and a half hours at a motor load well under rating.

After the second burnout the engineer placed the graphic wattmeter in circuit, and within about a week another burnout occurred. The chart clearly showed the fault to be with the operator. The first section illustrated gives the cycle under normal operation with an overload of short duration, a sharp drop, and then a safe, steady

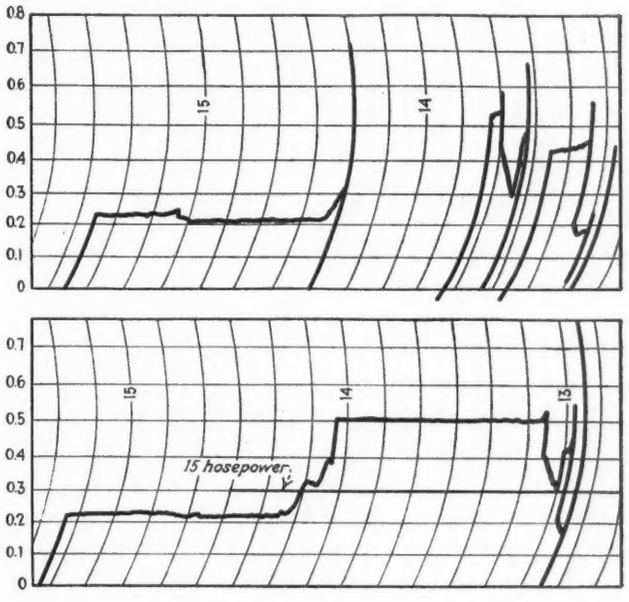


Fig. 3—Top graph shows normal and the bottom graph indicates faulty operation that burned out the motor

The hazard was remedied by installing signal lights to show the operator when the motor was running.

sustained load. The second section of the chart showed no dropping of the load, the overload being sustained because the operator failed to shut off the motor.

This conclusive proof of the source of trouble resulted in the operators responsible being disciplined and in the installation of a signal light in the circuit, which remains

lighted as a warning when the motor is running. The hazard has thus been eliminated.

There is a clear-cut saving here of about $150 per burnout, this covering rewinding, freight and labor. No time was lost in this case, as the six- to eight-hour period between digester loads allowed ample time to replace the motor.

Check of Machine Speed

The chart of the direct-current voltmeter used to check speed on the board machine occasionally shows a decline in the rate of feed of several feet per minute below the standard 194. Then the operator steps the speed up to normal, which is shown by a straight-line jump on the chart. All changes in speed caused by regulation or by pulp condition are clearly recorded, so that the operators are easily held to accountability.

The advantage of the permanent record of machine speed is not subject to evaluation, but is definitely found in uniformity of product and avoidance of waste, both considered important from sales or operating viewpoints. The investment of about $325 in the instrument on each machine is considered to be netting a satisfactory return.

The portable wattmeter, in service for about eight months, was recently calibrated. It proved to be accurate within 2 per cent, which is considered unusually good for a curve-drawing instrument of the portable type in frequent use.

Under present conditions the cost of supplies and calibration should not amount to over $25 a year for the portable wattmeter. Its life will depend largely on the care used in handling. The savings shown are already enough to pay for the instrument several times. The portable voltmeter is deemed equally necessary, but is used to a less extent. Costs on other instruments are considered low as compared with the benefits of permanent graphic records.

Where Are We Headed in Technical Education?

By W. E. Wickenden

Director of Investigations,
Society for the Promotion of Engineering Education

I HAVE been greatly impressed in my studies in Europe and America by the importance of seeing the problem of technical education whole and bringing some adequate initiative to bear upon it. Experience seems to indicate that it is equally perilous on one hand to leave the whole matter to some central bureaucracy and, on the other, to depend entirely on individual and local initiative.

Great Britain lost fifty years of her early lead over Germany through ineffectual development of technical education. Before 1880 nearly everything was left to private and local enterprise; few people perceived that a specially selected and trained personnel was needed to apply science to industry effectively; technical education in the universities was almost stifled before 1900 for lack of a suitable scheme of preparatory education; and nearly a century of effort was concentrated on the incidental scientific instruction of workingmen, largely inspired by welfare motives—an admirable thing, in itself, but a wholly inadequate scheme of technical education.

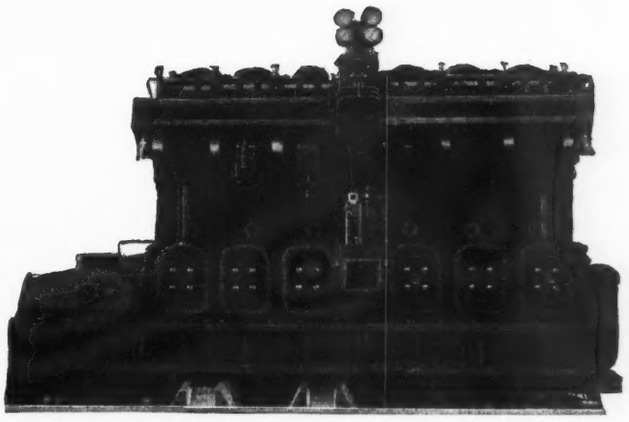
France showed remarkable fertility in creating a variety of technical schools, scientific, professional and industrial, and held undisputed leadership up to 1850. Then followed forty years of arrested development. The State held a monopoly but took no effective initiative; responsibility was scattered among various bureaus and ministries; each cared for its special needs; there was little concern for the needs of the country as a whole; the schools were unduly concentrated in Paris and the provinces were neglected; and nearly the whole effort went into the training of bureau chiefs and directors of industries, with the training of subalterns almost wholly neglected. It was forty years before local and private enterprise came to the rescue and seventy years before the State reassumed its responsibility for a balanced and adequate development. Meanwhile, the early supremacy in technical education had been irretrievably lost, with disastrous effect on French industrial development.

Technical education was thrown out of the older institutions of learning in Germany through the opposition of conservative educators and had the good fortune to be taken up and fostered by far-seeing statesmen who were engaged in transforming a group of backward agricultural states into a powerful industrial empire. Nowhere else have technical education and research had so large a share in shaping national destiny. New types of schools had to be created and there was an early period of confused effort. After 1860 it was increasingly evident that while the states and the industries were supplying much of the motive power, some influence was at work guiding the movement out of confusion into a well-ordered scheme. This was the *Verein Deutscher Ingenieure*, which later reached out and created a central representative committee, the *Deutscher Ausschuss fur Technisches Schulwesen*, which brings together the profession, industries, schools and government ministries for the concerted guidance and support of technical education in all its branches.

In the United States our pioneer efforts "to apply science to the common purposes of life," quickly solidified into the one special form of professional discipline for engineers. As a result of this early fixation one aspect of technical education alone has eclipsed all others; schools have been multiplied on the one pattern of the degree-granting college; the training of craftsmen, foremen and supervisors of industrial production has either been neglected or has been thrown back on industry itself; an undue premium has been put on going to college; the effort to make one sort of school cover too wide a range has led to indefiniteness of aims and compromise in standards; inadequate provision has been made for a large section of our youth; and industry has been given an unbalanced recruitment. We have done parts of the task well, but no one has seen the task whole.

It is plain that we cannot look to a central government to create and sustain a well-balanced policy and program of development. Industry cannot do it alone. The engineering profession is not yet awake to the problem. Our educators and schools are wrapped up in their own local and special interests. The S.P.E.E. is not an adequate agency as it stands, but it is the best nucleus we have to start with. If it could take the initiative in bringing the now scattered interests together in conference and promotion and sustain it for ten years, we might prepare the way for some central representative agency, such as that in Germany, and awaken the public to the vital part that an adequate and well-proportioned scheme of technical education has in industrial prosperity and development.

Solid Injection Fuel Pumps



. . . and How to Adjust Them

By H. F. Shepherd

PERHAPS the next most vital part of the "common rail" system of fuel injection used in several solid-injection engines, is the fuel pressure-relief valve. This is simply a spring-loaded differential plunger along the lines of Fig. 1. The fuel pressure acts upon the annulus *A* formed by the plunger body and the tip, tending to eject the plunger through the stuffing box against the set spring pressure. If it succeeds in lifting the plunger *B* owing to the excess supply of fuel, as it normally does, the fuel escapes through the small hole in the seat. The stuffing box is packed with the same kind of material that is used for the spray needle and is rather firmly set up, since it must act as a damper on the valve chatter, that would otherwise be produced.

The discharge from the relief valve should not go back to the fuel-pump suction, as is too frequently the case, but should be delivered to the day tank by its own pressure. If returned to the fuel pump, entrained air is not automatically eliminated, as through the day tank vent, and heating takes place due to the wiredrawing of oil from a pressure of 4,000 lb. down to nearly atmospheric. The day tank dissipates this heat readily, but the fuel pump does not, and if the fuel is light and the heat considerable, the pump is readily vapor-bound.

The valve is provided with two adjustments, a permanent one on the spring spindle and an operative one which is conveniently manipulated by lever, cam and quadrant, by a screw and handwheel as at *H*, or by compressed air as at *D*, Fig. 1. Sometimes both air and hand control are fitted.

Operators often adjust the fuel pressure to the load. The only advantage gained by this practice, and that a doubtful one, is relief of the pump mechanism. Careful tests show that best economy at all loads down to one-quarter rating is obtained with the full-load fuel pressure prevailing.

The quick adjustment is useful mainly for starting and idling. If the starter turns the engine over at 60 r.p.m., the normal speed of operation being 300 r.p.m., the sprays are open five times as long as with normal speed and the charges for the first few revolutions will be five times the full-load charge if delivered at full pressure. This method of starting results in detonation and, possibly, in the blowing of cylinder head or valve

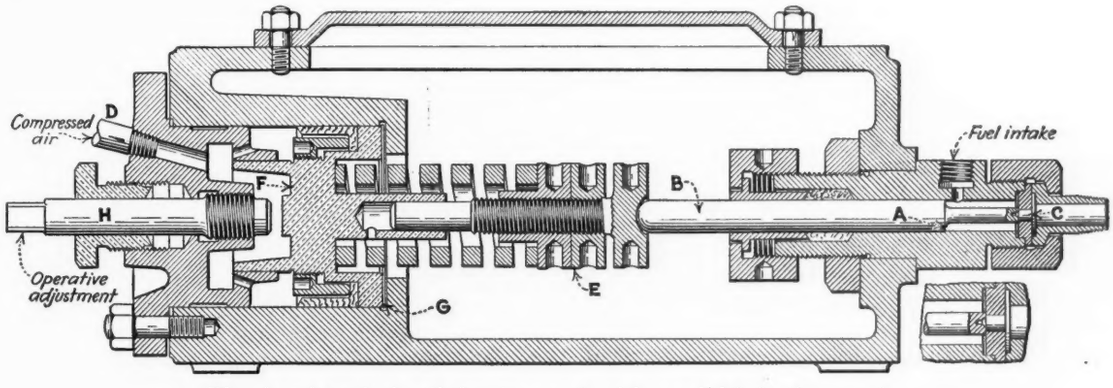


Fig. 1—A typical relief valve used with a solid-injection engine

gaskets with a cold engine. Consequently, engines are properly started and maneuvered with a fuel pressure from 1,000 to 2,000 lb., usually approaching the latter. If the normal pressure of full-load operation is 5,000 lb. per sq.in., the fuel flow at 1,000 lb. is $\sqrt{\frac{1,000-600}{5,000-600}}$ or about 30 per cent of the normal charge. The item 600 represents the explosion pressure. The first charges will then exceed the full-load charge by about 150 per cent, perhaps too little for easy starting of a cold engine. At 2,000 lb. pressure and under the same conditions the excess will be $5 \times \sqrt{\frac{2,000-600}{5,000-600}} = 282$ per cent, which is usually ample for cold starting. This is strictly true for governed engines and practically true of marine engines that are hand controlled, as the throttle is usually thrown well over to full speed in starting and withdrawn if the order telegraphed from the bridge is "slow" or "half-speed."

Starting the Engine

In cold starting only the lighter fractions of fuel are vaporized for the first few turns and an excess charge is required, just as the choke on a carbureter is useful until the car is started and warmed.

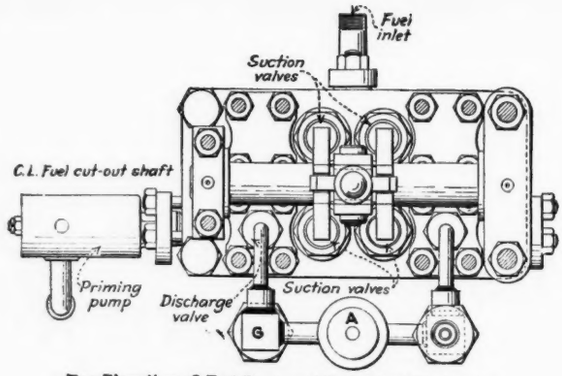
The low pressure is useful also in idling. At this time the engine lacks the heat necessary to stable operation. The penetration of the fuel jets is reduced with the pressure, and the fuel is better consumed in the center of the air charge and near the hotter center of the piston. It is just as useful for half-speed operation in ship propulsion, which is essentially idling, as at half-speed the resistance is roughly only one-eighth of the full-speed resistance and the brake m.e.p. is accordingly only one-fourth that at full speed.

With these things in mind the fixed spring adjustment is made first for the usual starting pressure. The screw, cam or compressed-air ram should be released to bring the spring to the operative position of least compression. The nuts *E* on the spring spindle, Fig. 1, are then set so that the fuel-pressure gage indicates, let us say, 1,800 lb. when the hand pump on the fuel system is operated. It will usually show a little more under the greater discharge of the main pumps. The nuts should then be locked. When the engine is up to speed, the pressure is then brought up, if the engine is to take on a load, by the use of the operative adjustment, watching the gage meanwhile. The compressed air ram *D* is useful for the switchboard operator or for quick control at sea. If both air and mechanical adjustment are fitted, it is common to maneuver or parallel under air control and then lock the ram in position with the cam-lever quadrant arrangement or screw.

Design of the Relief Valve

Like the spray valve the fuel relief is fitted with tapered or pointed valves, with the flat seat valve as an alternative. The lead hammer is a popular tool for seating the former; the lap must be used for the latter. Failure is usually by grooving out the seat due to dirty fuel and wiredrawing. The use of an oil centrifuge avoids much trouble. High chromium steel for both valve and seat prolong the life greatly and justify the additional cost.

The air ram *F* is packed with a leather cup and seats at the upper end of its travel against a leather washer *G* which is somewhat more impervious to air than the cup.



Top Elevation of Fuel Pump and Fuel Cutout Mechanism

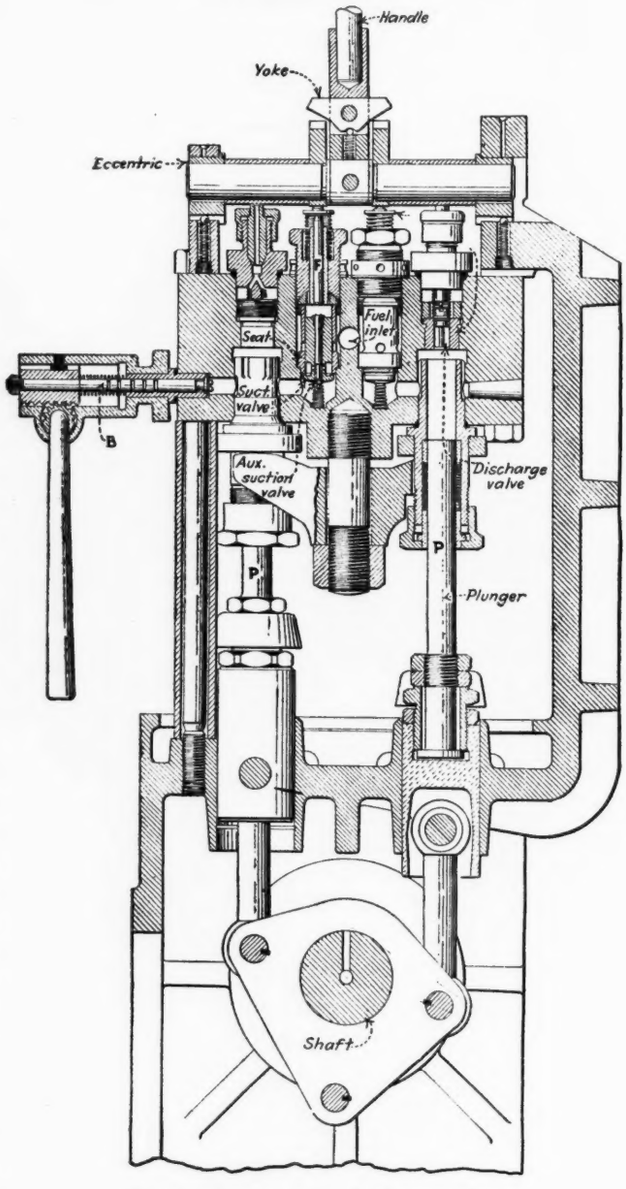


Fig. 2—Layout of a fuel pump for a "rail" system engine

No attempt is made to graduate the fuel pressure by manipulation of the three-way cock that admits and releases the air. The operation is properly between stops giving starting, idling and running fuel pressures.

The relief-valve housing is provided with a drain connected to a fuel sump or to the main underground tank.

The fuel pump is usually eccentric or crank driven either directly to each plunger *P* or through walking beams operating two plungers each, as in Fig. 2. The plungers are socketed into the crossheads so as to permit self-alignment with the stuffing boxes, which are packed with the same material as used for spray and relief valves.

Pump housings are either made enbloc with valves in cages or as single units connected with brazed steel tubing suction and discharge manifolds having union connections to each pump. These manifolds are concealed behind the gage board. The only unusual feature of the pumps is the projection of the suction valve stem or a plunger *F* contacting with it to the outside. This is useful in two ways. If any cylinder of the pump is airbound, its suction valve may be lifted to release the air or to assist the entry of oil into the pump if the suction is reduced by air. A leaking discharge valve or the combination of leaking discharge valve and air is detected by the great resistance of the suction valve against lifting by hand. A little auxiliary suction valve is centered in the main valve to make lifting easier with the pressure on.

How to Stop the Engine

The engine should always be shut down by throwing the sprays out of action, by shutting the isolating valves, by opening the vent valve on the high-pressure side, or by lifting the pump suction valves. Never shut off the fuel cock in the pump suction, for this will cause air to be drawn into the pumps along the suction-valve stem projections and repriming will be difficult.

Most fuel pumps are difficult to prime, but the operation need not be repeated except after repairs, unless the operator carelessly starts with the fuel cock shut off and draws air into the system. When reassembling after valve grinding, it is best to fill the pump with fuel by opening the fuel cock slightly and closing before the suction-valve plungers are in place. The valves may be depressed with a rod, allowing the air to bubble out. After this assembly may be completed. It is perhaps laborious but most satisfactory to do the same thing when air has been accidentally introduced; however, one cylinder may be primed by manipulating the priming pump and the corresponding suction valve diligently, pumping oil and entrained air through the vent valve. After this the engine may be started and air worked out of the other pump cylinders by the same means as already outlined.

Priming on Starting

The priming pump plunger *B* is provided with a seat on the end of the plunger in the conventional way and requires no packing. Large installations are provided with a separate motor-driven priming pump. Such an installation is particularly useful on ships operating in dense marine traffic or in locks. In such quarters there is little time to trifle with a pump that has accidentally received a volume of air.

The pressure-relief valve is connected directly to the fuel-pump discharge and not to the spray manifold, which is cut off from the rest of the system by a good non-return check valve. This enables the accumulator and manifold pressure to stand between stops even with a slightly leaking pressure-relief valve. It is quite common to find pressure standing on the accumulators after an overnight shutdown.

Byproduct Power and Higher Pressures

COMMON misconceptions regarding the relation of process steam and byproduct power call for closer thinking on this subject. This need for clear thinking is increased by the rapidly growing commercial application of high steam pressures. There is little need to emphasize the fact that power derived from process steam removes from the steam a trifling amount of heat, amounting to about one-third of a pound of coal per kilowatt-hour after allowing for all those losses (such as boiler losses, cylinder radiation, generator losses, etc.) that are not returned to the exhaust steam. This much is common knowledge, yet the necessary deductions are not always made.

That misconceptions exist is only too evident in many discussions of the problem of "balancing" heat and power loads. "Balancing" is perhaps an unfortunate word, for it immediately suggests equality. There is not the slightest necessity, theoretical or practical, for keeping the total steam exhausted and bled from engines, turbines and pumps equal to the process demand. All that fuel economy requires is that no exhaust steam be thrown to waste, either as free exhaust or as heat in condenser circulating water.

An excess of available power, making it necessary to supply part of the process steam through reducing valves, involves no fuel waste whatever except in the rare cases where an outside market exists for excess power.

Yet operating engineers of long experience have been known to watch their reducing valves as jealously as their atmospheric exhausts and to pride themselves on constantly shifting load from steam-driven auxiliaries to electric-driven and vice versa, to maintain the supposedly desirable "exact balance."

Practically, the thing to do is to provide, as far as fixed charges will permit, for an excess power capacity to act as insurance that the plant will operate at all times in the economy zone where some steam is passing through reducing valves.

Another basic fact, often overlooked, is that the kilowatt-hours that can be generated from one hundred pounds of steam is not a fixed quantity. It is illogical to say that the power and process demands are "equal" in a given manufacturing plant, because this "equality" is not merely a matter of the quantity of steam and kilowatts required, but is affected enormously by the boiler pressure, the back pressure and the efficiency of the generating units. Many a plant now generating one-third of its power as a byproduct could generate two-thirds by lowering unnecessarily high process pressures, raising boiler pressures and installing more efficient generating units.

The time has arrived for large industrial plants, in which the power demand per thousand pounds of steam used for process and heating is high, to give serious attention to the commercial possibilities of higher steam pressures. They have demonstrated their worth under the severe handicap of condensing operating found in central-station work. The saving in certain types of industrial plants will be immensely greater.

This does not mean that industrial plants should rush to high pressures in a body. At present, normal pressures are commercially more economical for certain conditions. Each case must be considered individually, taking into account of all special conditions.

LOW COST FURNACE CONSTRUCTION ... *gives excellent results*

Combination of water- and air-cooled walls at Pasadena Municipal Steam Plant, operating on oil with flame temperatures of over 2,900 deg., shows no signs of deterioration in six months' operation. The water walls consist of 4-in. tubes backed with plastic refractory and cost only $7 per square foot

By O. H. Hedrich

Mechanical Engineer, Municipal Light and Power Department City of Pasadena

WHEN the California boilers for No. 7 turbine generator unit at the Pasadena municipal steam plant were considered about a year ago, much thought was given to the proper cooling of the furnace walls in an attempt to cut down maintenance and increase thermal efficiency at a reasonable cost.

The furnaces of all previous boilers at this plant had been of the solid refractory type, either pre-burned shapes or plastic material, and much trouble in the way of boiler outage and maintenance of refractories was experienced. Furnace wall temperatures up to 2,920 deg. F. were attained at 250 per cent rating, resulting in melting down of even the highest-grade refractories, especially at the bottom of high walls where the compression load was high. It was therefore felt necessary to provide some form of cooled walls for the new boilers, which had 15,260 sq.ft. of straight-tube water-heating surface and a top rating of 326 per cent. In order to obtain proper combustion it was felt that the heat release should be kept down to something less than 40,000 B.t.u. per cu.ft. per hour. This required a furnace having a volume of approximately 5,500 cu.ft. and owing to the width and depth of the boiler the height of the combustion chamber was necessarily about 15 ft. in front and 20 ft. at the rear wall.

Certain physical conditions made it necessary to locate the forced- and induced-draft equipment on a deck above the boilers, and since the air for combustion had to be piped down to the burners, it was a simple matter to carry this air in a duct adjacent to the inclined rear wall and under the deck on its way to the burners. In fact, the steel plates supporting the refractory in the deck and rear wall were used as one side of this duct, and these portions of the furnace are then cooled by the air for combustion.

The side-wall cooling was more of a problem inasmuch as it was vastly more difficult to provide proper circulation of air behind these walls. Consideration of sectionally supported brick or tile walls was abandoned because of their inability to withstand the air pressure required at the high ratings. Cast-iron air-duct walls were satisfactory as far as air conduction was concerned, but they were expensive and did not provide what was thought to be the best protection to the refractory lining. The patented refractory armored water-tube walls, while eminently successful, were almost prohibitively high priced, and at that time some slight refractory troubles were being experienced. It was then that the bare tube wall was considered and eventually adopted.

As a matter of fact, bare tubes in the side walls are not subject to nearly as hard service as the first row of

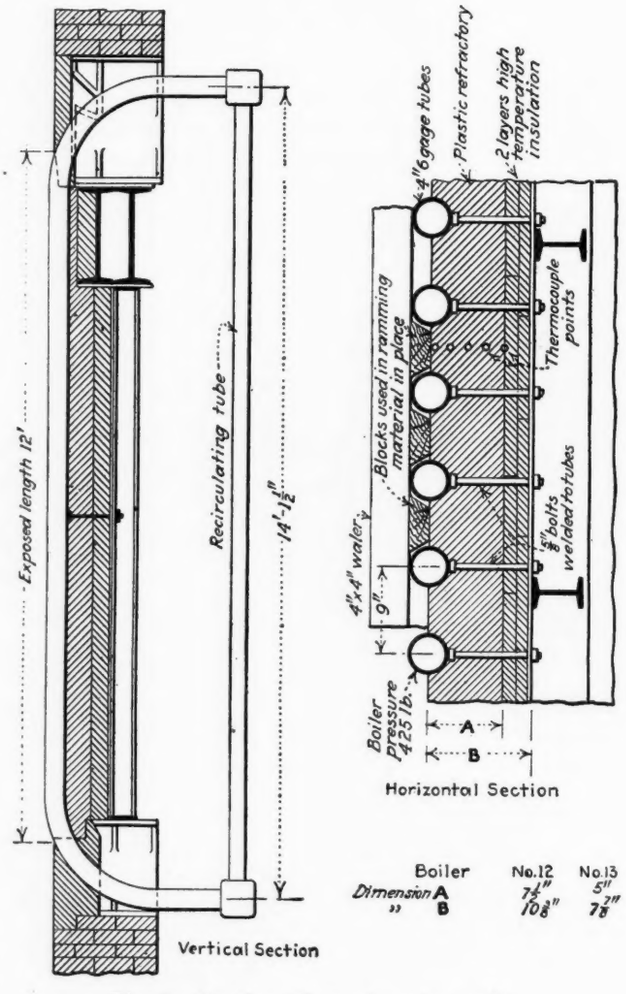


Fig. 1—Sections through water walls.

boiler tubes. Side-wall tubes must conduct radiant heat only, whereas the first row of boiler tubes are subjected to convection as well as radiant heat.

The original plans contemplated a shadow type wall; that is, solid refractory in back of, or shadowed by, a screen of bare tubes two or three inches away. This was given up in favor of a partly embedded type such as was finally used, which is shown in section in Fig. 1. Plastic firebrick material was admirably suited to such construction provided, of course, that it was properly installed. Blocks two inches thick and eighteen inches long were beveled to fit between the tubes as shown in the horizontal cross-section. These were backed up by 4x4 walers which in turn were braced to the opposite furnace wall. Two layers of high-temperature insulation with staggered joints were laid against the steel casing plate and the plastic material filled in. Air guns with 3-in. square tamping blocks welded to the drills were used to

DETAILED COSTS OF WATER WALLS

Water Wall Costs (per boiler)	1,526 Hp.
Material	
Large drums	$713.00
Water walls (bare, erected)	1,400.00
Plastic refractory	468.63
Superex insulation	108.28
Mineral wool	17.25
Welding supplies	34.15
Miscellaneous	4.95
Entrance tile	197.54
Cast iron inlet boxes	640.00
Steel frame and casing	241.11
Lumber for forms	100.67
	$3,925.58
Labor	
Steelwork	$160.58
Forms (up)	44.90
Forms (down)	10.31
Placing refractory	155.30
Placing rock wool	28.25
Total Labor	$399.34
Summary	
Material	$3,925.58
Labor	399.34
Total	$4,324.92
Wall area, sq.ft	616
Cost per sq.ft.	$7.03

drive the plastic in place. It was driven in firmly so as to become a heavy dense monolithic wall with no joints.

At the center of the vertical run of each tube a square-head bolt was electrically welded in place and the threaded end allowed to project through the steel casing. A nut was put on, finger-tight only, and in this way any tendency for the tubes to bulge into the furnace was avoided. The plastic refractory was held in place between the tubes and steel casing, which were tied together at top, center and bottom, thus making it impossible for the refractory to work loose and fall into the furnace.

In laying out the windbox and burner spacing, special care was taken to keep the wing or end burner a minimum of 48 in. from the side walls. Of course any impingement of oil spray on the bare tubes in the wall would eventually result in the burning out of such tubes. With good atomization and proper air conditions remarkably short flame lengths may be obtained, and there is really no danger of tube burn-outs if proper precautions are taken in design and operation.

Fig. 2 shows the temperature gradient through the plastic refractory under two different load and fuel conditions. Thermocouples were embedded in the refractory as it was being tamped in place in the No. 12 furnace west wall at a point slightly above and about four feet from the lower left wing burner. This was considered the hottest spot in the furnace. The thermocouple closest to the fire was placed midway between two tubes (that is, in the center of the five-inch refractory surface) and a quarter of an inch from the surface. The remaining couples were placed at equal intervals throughout the refractory, which was 7½ in. thick, and show a sharp gradient with either gas or oil. No. 13 boiler, similar to No. 12 and installed at the same time, had only five

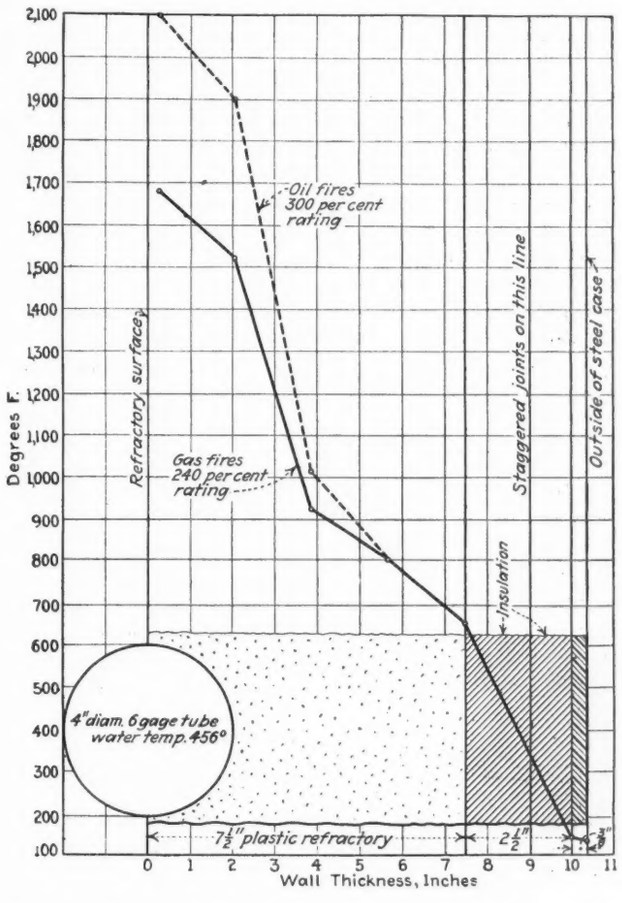


Fig. 2—Temperature gradient through furnace walls, No. 12 boiler.

inches of refractory in the furnace walls. This dimension was measured from the refractory face or tube center line, the thickness behind the tube being only three inches. Although no thermocouples were placed in this thinner wall, it is equally satisfactory and evidently quite as efficient as No. 12, inasmuch as the outside casing temperature is the same.

When burning oil at 300 per cent rating, the flame temperature in the firebox was 2,940 deg. F. at the center and 2,800 deg. at the wing burners. The surface of the refractory near the burners and between two adjacent tubes was 2,445 deg. F., while one-quarter inch back from the surface the temperature was 2,100 deg. These temperatures are low enough to insure a minimum of refractory maintenance. The walls have been in continuous service about six months and show no signs of depreciation. Some trouble was experienced at the beginning of operation with the special tile used to finish out the wall at the upper bend of the tube. These tiles were hung on cast-iron supports by means of projecting lugs. Owing to expansion strains the lugs started to crack off and drop the tile into the furnace. This difficulty was

overcome by removing these tile and ramming in plastic firebrick in their stead. Wedge-shaped fiber strips were placed around the bend of the tube before ramming the plastic and were later removed to leave a half-inch expansion space around the tube bend.

So far it has not been possible to take any pictures of these walls, inasmuch as no one has been inside the furnaces since replacing the special tile at the upper end of the tube. The only means of ingress is through one of the burner openings, and since inspection from all five peepholes indicates that the refractory is in perfect shape, we have not taken the trouble to remove a burner and make an internal inspection.

The cost of these walls is shown in the accompanying tabulation of labor and materials as taken from the work-order sheets. At a total price of approximately $7 a square foot the saving is a considerable item if some of the costs of commercial walls at $30 to $40 a square foot are used as a criterion.

The water-wall ensemble was designed and built in conjunction with the Pacific Coast office of the Walsh & Weidner Boiler Company, the regular construction crew doing all the refractory, insulation and casing work.

Fires in Coal Piles

SOME interesting comments on the causes of fires in coal storage piles were made by A. J. Hoskin, Purdue University, at the Indiana Fuel Conference last year. Following are some of his main points:

The universally accepted theory of spontaneous combustion of stored coal is that the coal is heated by its own oxidation; that is, by the combination of some of its substance with oxygen from the atmosphere. It has been proved that the quantity of heat generated is proportional to the quantity of oxygen involved, regardless of the rate of the reaction.

Ordinarily, the heat escapes to the atmosphere or the ground sufficiently fast to prevent any substantial rise in temperature; but occasionally conditions will be propitious for either an exceptionally rapid oxidation or a restricted removal of heat, so that a fire ensues.

Early in the history of coal storage the blame for occasional fires was laid upon sulphur or pyrite. This accusation was natural because sulphurous odors were noticed during the fires, and because the pyrite altered considerably whenever a pile heated, even though it did not burn. As a matter of fact sulphur has little effect.

Any fresh bituminous coal exudes a natural gas which is combustible and hence has heat value. It is the same gas (marsh gas) that causes disastrous explosions in coal mines. Unmined coal is somewhat saturated with this methane, whereas old or weathered coal is practically destitute of it. The rate of emission is at its maximum when the coal is freshly broken from the seam, and it is higher for the finer grades than for the coarser. Fresh screenings or mine-run yield this gas rapidly during a comparatively short period, which varies with different seams, districts and mines.

This gas, which is part of the so-called volatile combustible in coal, oxidizes readily and with the production of heat. Fresh coal heats spontaneously more rapidly than does old coal, and this is attributable to the more rapid emission of this gas by the fresh coal.

A mass of coal seldom fires if it survives the early period of storage during which it liberates most of its highly volatile component, this inherent gas. Numerous authorities believe that any mass of self-heated coal, having reached a dangerous temperature, if cooled successfully, is thereafter immune from heating. This might explain why coal that has undergone intermediate storage, or storage in transit, gives little or no trouble with firing during its final storage.

Some operators believe that proper ventilation prevents abnormal heating, while others condemn ventilation as the most potent factor in such heating. The favorable argument calls for a continual migration of fresh air in adequate quantity to absorb and remove the heat as it is generated. The adverse argument holds that a dangerous temperature is attained in a coal pile only because of a continual accession of fresh air.

Practices in storage based upon these opinions have netted unsatisfactory results. The full-ventilation notion is practically rejected, not because of theoretical error, but because certain limitations in every method that has been tried appear to induce rather than prevent dangerous heating.

A medium condition that may be termed restricted ventilation prevails in usual practices. An occasional fire indicates that air is available in sufficient quantity to permit a dangerous rise in temperature, and the usual explanation is that the air stored originally with the coal is augmented by fresh air that diffuses through the interstices of the pile, perhaps aided by wind pressure.

Many kinds of extraneous material find their way into coal during its mining and shipment or in storage. With the exception of metal scraps these foreign materials have lower ignition temperatures than the coal itself and therefore ought to be considered as potential kindling. Utmost precaution is required to see that storage coal does not contain bits of wood, paper, blasting fuse, rags, discarded clothing, waste (either dry or oily), charcoal, hay, straw, horse manure, weeds, leaves or twigs from trees, as well as remnants of coal from a former shipment or storage. Each of these types of kindling has been held responsible for coal-pile fires.

Cheaper Power Through Modern Equipment?

No, not always! Even the third plank of the *Power* platform has bumped into an exception—a case where cheaper power could not be had through modern equipment for the simple reason that modern equipment was as unattainable as the moon and almost as far away. Picture a Yankee engineer freezing in a Soviet prison camp after barely escaping a death sentence. He saw his opportunity and built a power plant of odds and ends from the four corners of the earth. Convict labor! No money! No tools! Not much of anything, to tell the truth. That the plant ran at all is to the everlasting credit of its designer and builder. Read his remarkable story as told in next week's *Power*.

Chart for Solving

Steam and Water Piping Problems

By P. M. GALLO
Carnegie Steel Company

THE design of piping systems for power plants or steam-distribution systems usually embodies a certain amount of tedious calculations to obtain the proper pipe sizes. These calculations often must be repeated for every rearrangement of the system considered. This consumes considerable time, as it must be done with sufficient accuracy to obtain reliable results. The object of this chart is to reduce this time to a minimum.

The size and layout of the steam-consuming units is usually decided on first. The pounds of steam per hour, pressure and superheat required by these units are given by the manufacturer. From these factors the boiler capacity required is derived, and from the general arrangement of the whole plant the piping system is designed.

The most economical piping system is attained when the sum of the yearly loss due to friction, radiation and velocity head and the interest on the investment in piping and covering is a minimum. If the size of pipe is changed from this, the total yearly cost of the system increases.

An equation can be derived giving the most economical size of pipe directly, but it is of a complex indeterminate form, not suited for general use. It is better and quicker to assume a pressure drop or velocity and find the corresponding pipe size. Then a few calculations on cost and interest will determine the degree of economy of the pipe.

There is no fixed rule for allowable pressure drop due to friction, as this varies somewhat with the operating conditions. The simplest way of procedure is to find the size of pipe to convey the required amount of steam at a velocity of 10,000 ft. per min., find the corresponding pressure drop, and then alter the pipe size to obtain the desired friction loss, remembering that pressure drop varies approximately as the velocity squared and inversely as the pipe diameter.

To use any chart intelligently, it is necessary to understand the basis of its construction. This is conducive of rapidity and accuracy in solving any problem within its scope.

The chart is based on the pounds of steam required per minute and the steam pressure, as these are furnished by the manufacturers of the various units, and are the first rational quantities encountered in the design of a power plant or boiler unit.

The scales are clearly labeled and self-explanatory. The gage pressure lines represent the pressure at the throttle or point of application. The velocity curves have two velocities marked on them. The higher velocities of 1,500 ft. per min. and over are for steam; the lower velocities of $2\frac{1}{2}$ ft. per sec. and over are water velocities. The water velocities are obtained by dividing the steam velocities by 10 and by 60 to reduce to feet per second, thus avoiding possible confusion.

The chart is arranged in two sets of scales, A and B, to give a greater range with equal accuracy. The same lettered scales are to be used together except in special cases. For example, problems involving the water and vacuum lines do not follow this rule, the change being necessary to bring them within the range of the chart. The lower scales B and B_1 are one-tenth of the corresponding upper scales A and A_1. Scale B_2 is scale A_2 divided by the square root of ten.

For water calculations the scales must be crossed to make the chart direct reading; that is, use A_1 with $B_2 \times 10$, or B_1 with A_2. Also, for vacuum-line calculations the scales must be crossed to come within the range of the chart; that is, use scale A with $B_1 \times 100$ and $B_2 \times 10$ or use scale B with scales A_1 and A_2.

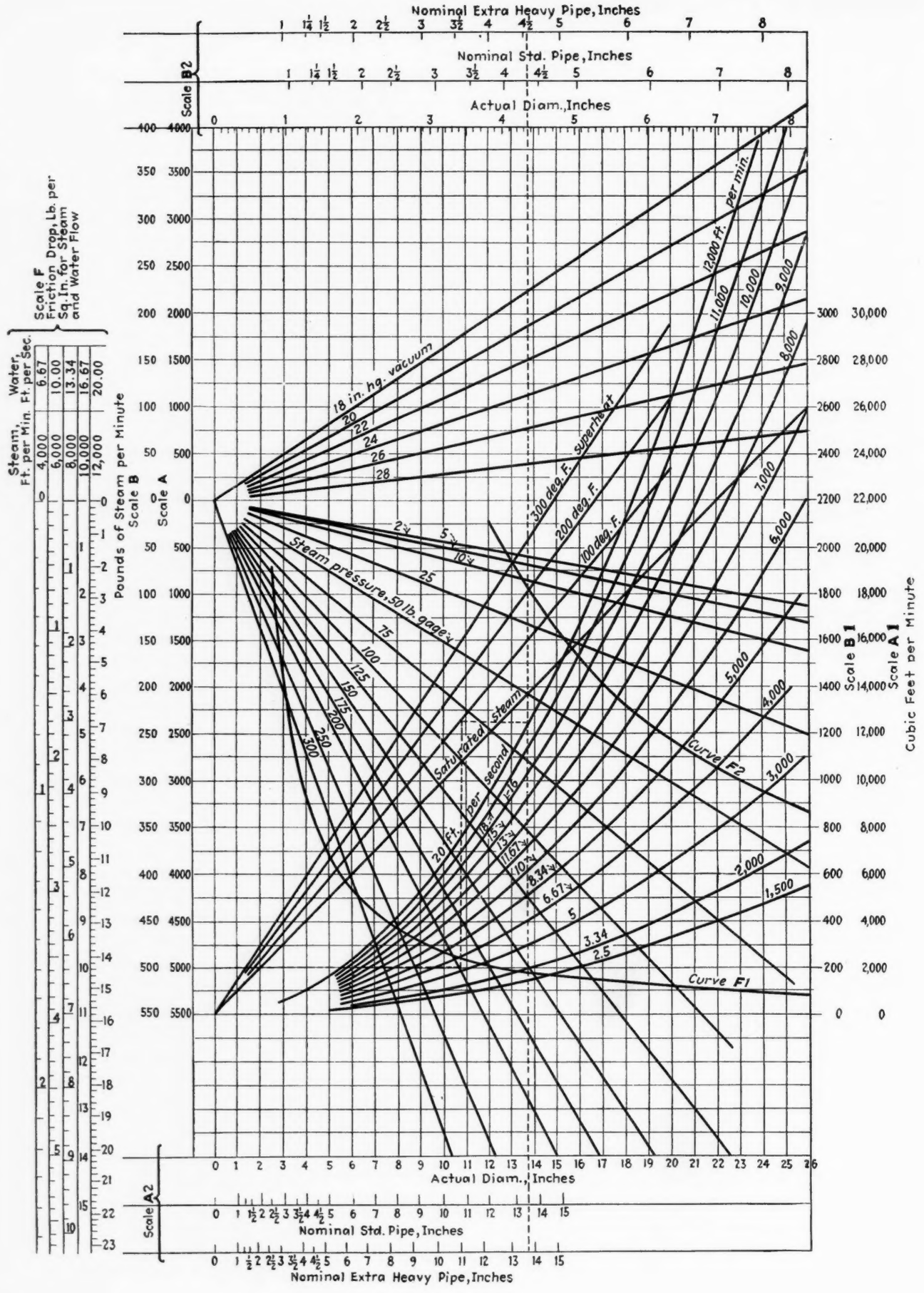
To make the chart universal in its application, friction curves and scales have been added. The friction loss is given in pounds per square inch per 100 ft. of smooth straight pipe at various steam velocities. The minimum number of curves for the proper degree of accuracy is two, curves F_1 and F_2. In scale F the corresponding pressure loss due to friction is given for several velocities. The superimposed pressure drops at different velocities as given in this scale are more convenient than a series of curves, as they show at a glance the pressure-loss variation for different velocities of steam in a given pipe. Curve F_1 can be used for pipe of any size. For greater accuracy in reading the rapidly decreasing pressure loss as the pipe sizes increase above 12 in., curve F_2 should be used and scale F divided by 10.

The pressure drop due to friction was calculated from the generally accepted equation for the flow of steam in pipes

$$W = 87\sqrt{\frac{wpd^5}{L\left(1+\frac{3.6}{d}\right)}}$$

where W = pounds of steam per minute, w = density of steam, d = pipe diameter in inches, L = length of pipe line in feet, and p = pressure drop in pounds per square inch.

Since the water velocities are one-tenth of the steam velocities, and w for water is 62.5 lb., by multiplying the velocity value of scale F by $\frac{62.5}{100 \times 31} = 2.02$ or, say, 2.


Nominal Extra Heavy Pipe, Inches
Nominal Std. Pipe, Inches
Actual Diam., Inches
Scale B2
Scale F
Friction Drop, Lb. per Sq. In. for Steam and Water Flow
Water, Ft. per Sec.
Steam, Ft. per Min.
Pounds of Steam per Minute
Scale B
Scale A
Scale B1
Scale A1
Cubic Feet per Minute
18 in. hg. vacuum
20
22
24
26
28
300 deg. F. superheat
200 deg. F.
100 deg. F.
Steam pressure, 50 lb. gage
2½
5
10
25
75
100
125
150
175
200
250
300
Saturated steam
20 Ft. per second
12,000 ft. per min.
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,500
Curve F2
Curve F1
Scale A2

the pressure drop due to friction of water per 100 ft. of straight smooth pipe is obtained, which agrees very well with Darcy's formula. For water always use the 125-lb. steam-pressure and saturated-steam lines as reference.

The pressure loss due to friction of elbows, tees, bends, valves, etc., must be added to that obtained for straight pipe from scale F. For curves or bends of a radius equal to or greater than five pipe diameters the friction loss is the same as a straight pipe of equal linear length as the pipe in the bend. For water piping the pressure loss due to friction should be increased 30 to 50 per cent to allow for incrustation, pitting and sediment.

Operation of the Chart

A few examples will serve to illustrate the use of the chart and indicate the various types of problems that can be solved with it.

Assume it is desired to find the pipe size, cubic feet per minute and friction drop when 5,000 lb. per hour of steam at 200 lb. pressure and 100 deg. superheat flows through a pipe at a velocity of 12,000 ft. per min. Enter the chart at scale A and proceed horizontally to the pressure line marked 200 lb., then vertically to the superheat line marked 100 deg. and horizontally to the 12,000 ft. per min. velocity curve. From here the pipe size of 14-in. is read on scale A_2, and the steam volume on scale A_1 to be 12,500 cu.ft. per minute.

If the steam flow had been 500 lb. per min., the operation of the chart would be the same except that scales B, B_1 and B_2 should be used. If the capacity of a given size pipe is required, the operations should be reversed.

To find the pressure drop due to friction, start with the pipe size on scale A_2, proceed vertically to the friction curve F_1, horizontally to the 100-deg. superheat line, vertically to the 200-lb. pressure line and horizontally to scale F, where the pressure drop per 100 ft. of pipe may be read from the scale corresponding to the steam velocity in the pipe, which in this case is 12,000 ft. per min., and the friction loss is 2.1 lb. pressure. If curve F_2 is used instead of F_1, proceed in the same manner but divide the F scale by 10.

To find the friction loss when water is the fluid, proceed in the same way, using the 125-lb. pressure and saturated-steam lines as reference lines, and multiply the F scale by two when curve F_1 is used and by 0.2 when curve F_2 is used.

With the flow of water in pounds per minute given, scale A must be multiplied by 2, then using the 125-lb. pressure and saturated-steam lines as reference lines, the volume of water can be read from scale B_1 divided by 10. To find the pipe size, proceed horizontally from scale B_1 divided by 10 to the velocity curve marked in feet per second and then vertically to scale B_2. If scale B_1 is used as marked, the pipe size is given by scale A_2, and if scale A_1 is used, $B_2 \times 10$ gives the pipe diameter.

When working problems involving vacuums, start with scale A and proceed horizontally to the vacuum line, vertically to the saturated-steam line and horizontally to scale $A \times 10$ for cubic feet per minute. To find the pipe size, proceed from the velocity curve to scale $B_2 \times 10$. Or use scale B with scales A_1 and A_2 as marked.

When the values to be used exceed the chart scales, the scales may be altered to suit by multiplying scales A and A_1 by any factor and scale A_2 by the square root of the factor, by multiplying the velocity curves by any factor and dividing scales A_2 or B_2 by the square root of the factor.

The Case for the Deaf Engineer

By D. A. Hampson

ALL through the factory the machinery was in bad shape. Hammers were shaking themselves apart, presses were pounding, grinders had worn clear through the babbitt in their bearings. It seems that the business had been milked dry by the previous owners before passing it off on the present ones, to whom everything in iron had looked like good machinery.

To the credit of the present owners be it said that they are making the best of a bad bargain and are actually making headway toward an upright position. But it will be a long time yet before there is any money available for new machinery.

The way out led through the power plant, and there I stopped to look at the engine. It was an 80-hp. Corliss, carrying easily its drag load of worn machines and misaligned shafting. While I stood gazing, the engineer-fireman came in from the next room. Following my glance, he volunteered, "Yes, she's pretty dirty. I haven't had any waste since I came two years ago. I bring rags from the house when we have them to spare which is not every day."

But I wasn't thinking of the dirt. As a matter of fact the engine was pretty clean. I was trying to make out the cause of that click, click at the end of each stroke, that didn't seem right, but must be or this man would take care of it. I had just replied that the engine looked clean to me when he broke in with, "I look all around every day to see if any nuts or keys have dropped off." Engine's been here since 1910 and never had a single penny spent on her."

That reply tipped me off to the man's condition, and I soon proved that he was stone deaf. No wonder there was a noise made inside that cylinder 180 times a minute without any heed being paid.

To be sure that the trouble was inside, I went over the engine carefully. The main bearings were cool, yet tight, and both ends of the rod were as silent as the grave. As to the valve gear, only the usual noises were present there and they did not synchronize with the one I sought.

This engine was afflicted with what a motorist would call "piston slap," but just what was the exact trouble nothing short of an inspection would reveal. The noise could be heard 50 feet from the building. Whether a broken ring or some other part of the piston was "gone" could not be said, but the sound was quite different from a loose piston or a shoulder knock. I once found an engine with a similar noise running with no expansion rings and with the bull ring loose.

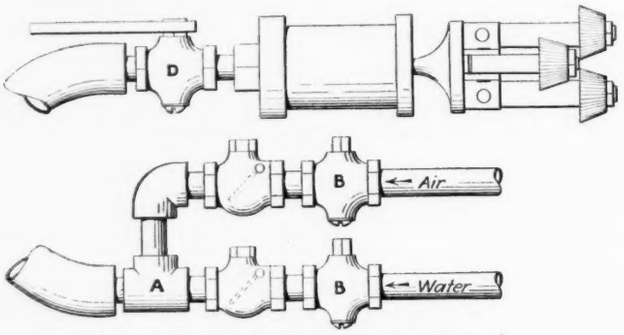
Whatever the trouble was, the afflicted engineer knew nothing of it. Evidently, his department was run on a "What he doesn't know won't hurt him" plan, and all the employees had been tipped off to say nothing about it. There was something radically wrong inside that cylinder and only the inherent stamina of a Corliss engine, second-hand when it was put in, kept it going. It made me wonder if the former engineer had left under duress or not and if the hiring of a deaf man hadn't been a master stroke of finance.

The question as to the advisability of entrusting a power plant to a man whose deafness prevented the detection of trouble is one the reader must answer for himself. Still it is something I would not care to do in any plant.

Right Out of the Plant

Air and Water Used to Drive Boiler-Tube Cleaner

WHEN our water-tube boilers were first put into service, the tubes scaled badly and the boilers could be operated only a short time without putting a cleaner through the tubes. We used what we believed to be one of the best tube cleaners obtainable. We kept the cutter wheels sharp and used water for driving the cleaner at the pressure specified by the manufacturer (100-125 lb.).



Arrangement of air and water connections

The cleaner, however, did not seem to run fast enough to clean the tubes properly, and it took an unusually long time to do the job. By way of experiment we connected compressed air to the cleaner, and it then ran fast enough to clean the tubes in a reasonable time. Finally, we connected both air and water to the cleaner. The air gives it the necessary speed to do the work and the water keeps it cool and washes away the dirt.

The illustration shows how the connections were made. *A* is a circulating tee. The cocks *BB* are adjusted to the requirements. It is not necessary to have the air and water pressures the same. In operation, of course, the cock *D* on the turbine end of the hose is used. This combination of air and water on the tube cleaner is still in use and works well. W. L. PARKER.

Low Pressure in Boiler Room Caused Combustion Trouble

WITH reference to the article by A. E. Smith in the Feb. 5 issue on "Low Pressure in Boiler Room Caused Combustion Trouble," conditions where a minus pressure occurs in the boiler room are quite prevalent; this, of course, exists generally without the knowledge of the operating force. In order to overcome conditions referred to by Mr. Smith, an air inlet opening should be left at some point in the building, to be closed by a swinging door which cannot be locked in a closed position but which will stand normally in such a position. It can readily be seen that where there is a tendency to a minus pressure in the boiler room, these swinging doors will open sufficiently to balance the pressure conditions.

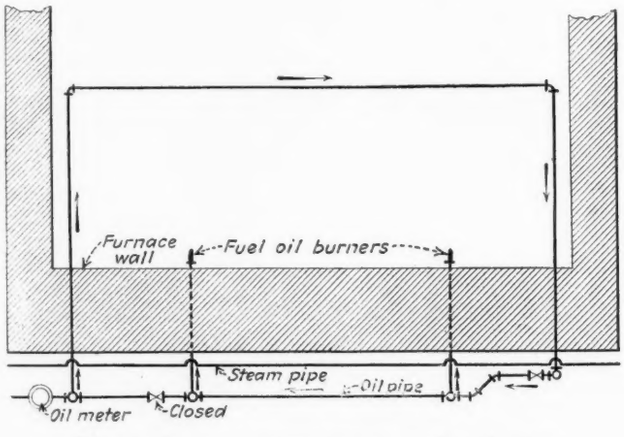
It is rather surprising that the open ventilator entered into competition with the stack, as explained by Mr. Smith, as there is quite a discrepancy as far as weight of gases is concerned. This discrepancy is enormously in favor of the stack which should really result in a reverse flow of air through the ventilating system. In fact, in some large steam plants it is necessary to warn the operators against closing off the ventilating system during the winter months, which they will invariably do in order to prevent reverse air currents or flow of outside air into the plant, with consequent discomfort to the operators.

When one regards the enormous quantity of air required for combustion, it may be considered remarkable that so few troubles are experienced on account of insufficient air in boiler rooms. Large central stations, of course, take care of this condition by providing regular air ducts with doors swinging inward, as previously mentioned. JOHN F. HURST.

Louisville, Ky.

Preheating Fuel Oil in the Boiler Furnace

OUR oil heaters, when first installed, were connected in parallel and utilized the exhaust steam from the oil pump. The oil was received at the rate of approximately 9,000 gal. a day at a temperature of from 140 to 190 deg., and, as it was recirculated, the temperature at the suction of the pump was about 114 deg. After passing through the heater, the temperature was about 135 deg., but on account of the distance from the pumphouse to the burners the temperature dropped to about 122 deg., which was much too low for proper atomization.



Pipe in furnace serves as a secondary heater

We later connected the heaters in series and the temperature increased about 20 deg. We then lagged the heaters and raised the temperature about 8 deg. more, but the temperature of 150 deg. at the burners was still too low.

The chief engineer then conceived the idea of running a pipe through the boiler furnace and heating the oil by circulating it through this pipe. After it had gone

through the oil meter, it was run into the furnace through a 1-in. pipe and back into the line that fed the burners. Firebricks were placed on top of the pipe in such a way that they could be removed by a bar if the oil was not hot enough. Valves were placed on the line in such a manner that if anything happened to the piping within the furnace, the burners could be operated at the lower temperature as previously.

The improvised heater proved satisfactory and saved us the cost of a new steam heater. After removing a few bricks, we found that the oil temperature, after passing through the furnace, averaged about 210 deg., varying from 200 to 212 deg., which was the temperature we desired. No evidence of carbonization has been noticed after operating for about six weeks, and the operation of the burners has been much improved. W. H. Scott.

North Woburn, Mass.

Static Condenser Oil Must Be Free From Moisture

STATIC condensers are coming into general use for power-factor correction on alternating-current systems. In the majority of cases condensers of large power are made up of a number of small units placed in a tank of oil. The oil assists in cooling and also serves as an insulator. The efficiency and reliability of a condenser depend upon this oil fulfilling these two functions correctly.

The oil used is either a transformer oil or a similar grade. It must be free from substances that tend to destroy its insulating qualities and must not sludge when subjected to high temperatures. Lowering of its insulating properties by absorbing moisture is the most common trouble with good oil. Minute traces of moisture will greatly lower the insulating properties of oil. This may permit electrical leakage within the condenser, causing increased heating of the oil, and may result in a breakdown. Moisture in condenser oil has caused two breakdowns that I know of.

In the first case the moisture was absorbed when the condenser had been opened for inspection. During this time the condenser units absorbed moisture from the atmosphere. Electrical leakage took place between the units, which decreased their efficiency and finally caused a breakdown, after which several of the units had to be replaced.

In the second case moisture entered the insulating oil and the electrical leakage caused the oil temperature to rise. This was noted on the thermometer by the attendant, but the fault was not rectified and the condenser ultimately broke down, making extensive repairs necessary.

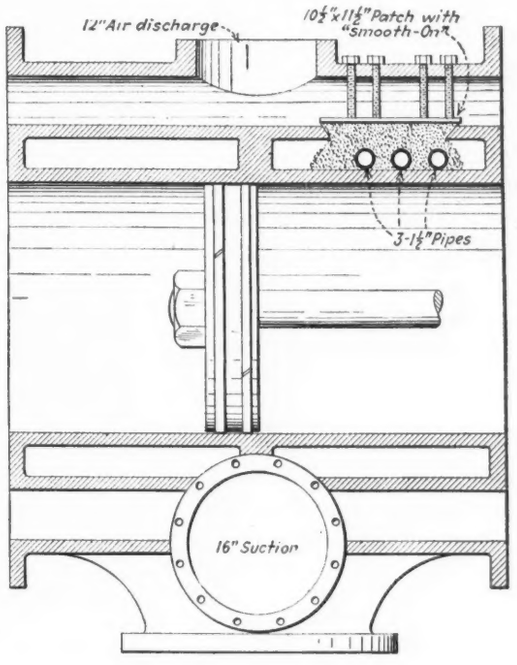
Failures like these show the necessity of keeping the oil in condensers free from moisture. Where a thermometer is fitted to the case, any excessive rise in the oil temperatures should be investigated. The oil should be periodically tested for moisture. If moisture is found to be present, the oil should be removed and replaced or filtered to restore its insulating qualities. Passing it through a centrifugal purifier or a filter press will remove the moisture and suspended matter. Oil quickly absorbs moisture from the atmosphere, and a short exposure to a damp atmosphere will materially lower its dielectric strength. W. E. Warner.

Brentford, England.

Iron Cement Used to Repair Compressor Cylinder

THE illustration shows how we repaired a leak in the water jacket of a 29x30-in. air-compressor cylinder. The leak was caused by a sand hole in the casting, and the metal surrounding it was very thin, apparently owing to the shifting of the core when the cylinder was cast.

An electric welder was called in and upon inspecting the leak he said that he could weld a patch on and make a satisfactory repair. He stated, however, that he would have to make a larger hole so that he could get his patch on the inside and do his welding on the outside, the patch to be made in two pieces to allow for expansion. The patch was finally welded in place, but when the water pressure was applied it leaked badly and the welder spent another day trying to stop the leaks. Then it was discovered that the expansion had cracked the casting close to the hole, so a larger patch in three pieces was tried with the same results, and considerable more cracking around the patches. A third patch in four pieces was then tried, the welding being done one inch at a time and that allowed to cool before proceeding further. This patch also was a failure and the welder finally gave up. He had worked approximately eight days and had increased the size of the hole from 4x5 to 9½x10 in. As a new cylinder would cost approximately $2,000, we decided to try a repair with Smooth-On.



How the hole in the water jacket was repaired with iron cement

The hole was in a very inaccessible place, being in the lining of the water jacket between the cylinder proper and the air discharge passage, so the job was a rather difficult one. To avoid obstructing the water circulation in the jacket, we cut three pieces of 1½-in. pipe 18 in. long, bent these to the proper radius and put them in position against the wall of the cylinder, as shown in the sketch. We then mixed up a five-pound can of No. 4 cement and spread it on these pipes. This was followed with a piece of heavy ½-in. mesh wire and another coating of cement. We

repeated this until we had mixed up six five-pound cans of cement. This was allowed to set several days. A piece of steel plate was then bent to the proper radius and secured in place on the top of the patch by four ¾-in. studs as shown. Additional cement was put on to cover the work one-half inch thick before putting the plate in place.

When the job was finally tested, it proved to be water- and air-tight, and the compressor has operated without further trouble. W. L. LAPWORTH.

Pittsburg, Kan.

Beware When Entering Boiler

THE short article on "Beware of Dead Air When Entering Boiler," together with the reference to industrial accidents in Mr. Low's Foreward, in the Feb. 5 issue, contains thoughts that can hardly be brought to mind too often. The items touched on which particularly interest me, by reason of my personal contact with them, are:

1. Not to enter a boiler too soon after it has been taken off the line for inspection.
2. Avoidance of open lights in boilers that had been fired with gas or oil.
3. Closing of blowoff valves.
4. Notifying employees not to touch valves when a boiler had been entered.

Such and many more warnings seem so trivial and obvious that carelessness often occurs. I have seen such accidents occur even when the men should have known better. I might add one warning that perhaps would have prevented two accidents that happened in one plant, "Beware of leaky valve in entering boiler."

Only the strictest caution at all times, warning signs on the boilers and valves involved, and posted instructions, together with personal supervision of the foreman, backed up by periodic safety meetings of instruction, can keep up continual watchfulness. I am for repeating these warnings often. L. G. JONES.

Pittsburgh, Pa.

Use of High-Pressure Steam on Soot Blowers

WITH respect to the question that appeared on page 106 of the Jan. 15, issue, "Since high pressure steam in a soot blower may cause tube cutting, at what pressure is one justified in installing a reducing valve?" as far as our company is concerned, we do not consider this a problem, since we do not use high-pressure steam for soot-cleaner purposes. On all high-pressure jobs we furnished a flanged orifice fitting to be placed in the header, which reduces the boiler operating pressure to approximately 200 lb. We are assuming, of course, that the pressure to start with is high and perhaps around 400 or 500 lb. The size of the orifice is figured for the particular job and, of course, varies somewhat for each individual installation.

The flanged fitting is low in cost and should not be omitted for the sake of saving a few dollars on the job. We feel that good engineering practice demands that the orifice fitting be furnished where high steam pressures are used. The fitting is so simple and easy to install that we cannot see why any operating engineer would want it left out.

Furthermore, there is another angle to this proposition to consider, and that is the one of steam saving. We have found from experience that the best and most efficient soot-cleaning results can be secured from pressures around 200 lb. In this respect we would refer to an article that appeared in the June 30, 1925, issue of *Power*, page 1035, entitled "The Soot Blower." According to this article, if the operating steam pressure of the boiler is around 400 lb. and we reduce it to 200 lb. for soot-cleaning purposes, then we will effect an economy of about half of the steam which would be used, provided we did not have the orifice plate in the line and the pressure was not reduced to 200 lb. This is a big factor in soot-cleaner practice.

W. C. IHDE, Sales Manager,
Du Bois, Pa. The Vulcan Soot Cleaner Co.

Hints on Truing Up Commutators

ECCENTRICITY is often a troublesome defect in commutators. Some of them tend to wear eccentric, and this not only unbalances the commutators but causes considerable vibration of the brushes. Whether turning or grinding is employed to true a commutator, it is always possible to reproduce eccentricity due to spring of the tools or defects in the lathe. When turning in its own bearings, the shaft may run off center because of too much play in the bearings.

Before starting to true up a commutator, the holding bolts should be tried for tightness when the commutator is hot. The spaces between the commutator risers should be covered with canvas or cloth to prevent dust being carried inside the armature. If this is not done, a small electric fan placed at the back end of the armature to blow a current of air out over the commutator will prevent dust getting into the windings. Whether turning in the machine bearings or in a lathe, light cuts and sharp tools should be used, for without these accuracy in the finished surface cannot be obtained.

For turning purposes I have found that a tool with a diamond in the point gives much better results than an ordinary steel tool. There is an absence of chatter, and the mica or slots between the segments do not distort the cutting point as with a steel tool. Diamond-pointed tools are satisfactory only for light cuts, and if much metal has to be removed it is best to take the roughing cuts with steel tools and finish with the diamond tool.

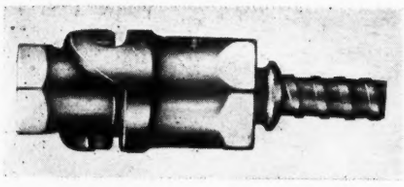
Much higher turning speeds can be used with diamond tools than with steel. Some commutators 2½ in. in diameter have been successfully machined at a speed of 2,000 r.p.m., larger commutators at speeds up to 1,200 ft. per min. The finish given by the diamond tools is superior to that obtained with ordinary turning tools.

When the truing operation has been finished, the commutator should be tested all around its circumference to see that it is not out of round more than 0.002 in. If the truing has been done with the armature in the machine, all parts should be blown out to remove the dust that may have collected. At the same time it is advisable to clean out and relubricate the shaft bearings. After this, the machine should be given an insulation test to detect faulty insulation. This test should be followed by a second one after the first run. In this way possible electrical fault, which could develop through the accumulation of conducting dust, can be detected and remedied before other trouble develops. W. E. WILLIAMS.

Manchester, England.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES



Air-hose coupling with leather gasket

Small Air-Hose Coupling

THE air-hose coupling illustrated has no springs or loose parts. A quarter turn connects or disconnects the coupling. A special leather gasket, which is not affected by oil or other air-line substances, is used. The gasket is expanded by a V-shaped sliding ring when the pressure is applied. The coupling, with the hose shank, is 3½ in. in over-all length. It is made in a number of sizes by the Robinson Machine Company, Muskegon, Mich.

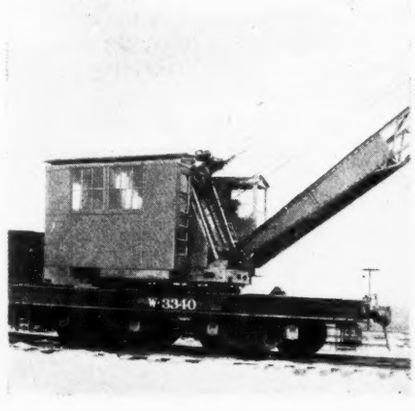
New Line of Gasoline Locomotive Cranes

A COMPLETE line of locomotive cranes designed especially for gasoline engine, Diesel engine or electric motor drive, to be known as the "L" type, is announced by Link-Belt Company, Chicago, Ill.

The units are designed for the severe conditions imposed by a power unit running continuously at its full operating speed and are particularly adapted to direct engine or motor drive. All clutches, brakes, shafts, bearings, gears, etc., are oversized. The drive from engine or motor is a totally inclosed silent chain drive, and all upper frame gears have machine-cut teeth, cut from solid blanks.

Each unit is furnished with a two-speed travel gear to give a high speed for traveling light, and a slower travel speed for pulling heavy loads or ascending comparatively steep grades. The "L" type crane is manufactured in five sizes.

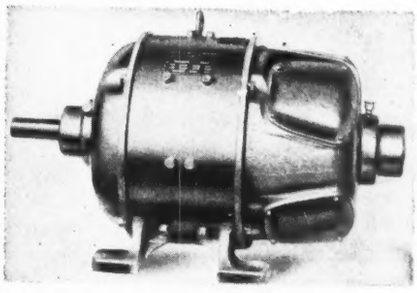
L-type cranes designed for internal-combustion engine and electric motor drive



Peerless flexible shaft unit

Flexible Shaft Unit for Various Services

THREE types of mountings are provided for the flexible shaft grinder illustrated. These are a pedestal mounting, a trolley mounting for overhead monorail service, and a portable-type bolted to a plate. The flexible shaft is driven by a ½-hp. motor suitable for operation on 110- or 220-volt, 60-cycle circuits. The motor speed is 1,750 r.p.m., but it can be furnished for operation at 3,500 r.p.m. The length of the flexible shaft is 6 ft., and it may be used to drive grinding wheels, buffing wheels for cleaning condenser tubes and a number of other services. Shipping weights of the portable and trolley types are 75 lb., and of the pedestal types 200 lb. The tool is put out by the Peerless Electric Company, Warren, Ohio.



Totally-inclosed watertight motor

Watertight Motor for General Application

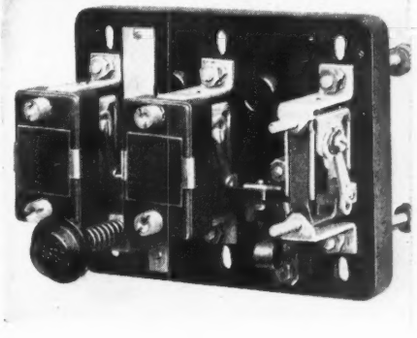
ALTHOUGH designed primarily for hoist duty, the watertight motor illustrated is also suitable for general application in damp places. It is rated at 15 hp., 230 volts, 1,150 r.p.m. for 30-min. duty, with 55-deg. C. temperature rise. It is compound-wound for operation on direct current and is reversible.

The bracket on the pulley end of the motor is cast solid, whereas the bracket on the opposite end has four watertight handhole covers, the removal of which permits easy access to the commutator brushes and rigging. The motor is manufactured by Roth Brothers & Company, 1400 West Adams St., Chicago, Ill.

Relays Have Renewable Heating Element

A NEW line of double- and triple-pole temperature overload relays is offered by the General Electric Company. In this design, shown in

Relay protects three legs of a circuit



the figure, the heating elements can be easily removed and inserted and a third relay unit can be added on the same base when it is desired to protect three legs of a circuit. Both forms are rated at from 30 to 150 amperes and are available for either front or back connecting.

The back-connected types are for panel mounting, but use the same base as those with front connections. On inclosed panels air drafts are eliminated by the inclosing case, but on open panels it is necessary to use a cover over the relay.

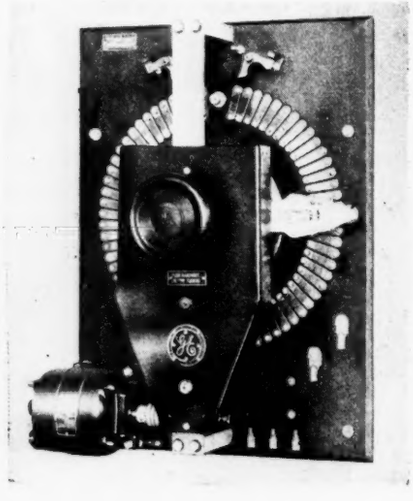
An electric reset is provided as an accessory. When used with a relay which is mounted at the bottom of a base, a sub-base is added. The sub-base is clamped to the main base by the relay itself. Where there is sufficient space, the reset relay can be mounted on the panel itself.

New Radial Switches Have Renewable Segments

A NEW line of radial rheostat switches, for general application where the current is more than 50 amperes and not over 300 amperes, is announced by the General Electric Company, Schenectady, N. Y. There are five forms—for hand, sprocket, gear, solenoid and motor operation. These bear the designations CR-8090, CR-8190, CR-8290, CR-8390 and CR-8490, respectively.

An outstanding advantage of the new switches is the fact that they have renewable segments. By removing two screws any segment may be taken off without disturbing the resistor leads. The segments may be reversed for increased service.

Motor-operated switch with renewable segments



The switch designed for 100-ampere service has 65 divisions, the 200-ampere switch has 48 divisions, and the 300-ampere switch has 40. All switches of a given current rating have the same number of divisions, irrespective of how they are operated. This permits changing from a sprocket-operated switch to a solenoid- or motor-operated one, by exchanging the switches and reconnecting the leads, having the same number of governing points. For the smaller hand- or sprocket-operated devices, a 50-division switch, similar to the 65-division form, is available.

New Multiple-Retort Stoker

A NEW multiple-retort stoker embodying a number of important features is announced by the Combustion Engineering Corporation, New York City. Practically the entire area of each retort has been made active underfeed area. This tends to give even fuel distribution over the entire grate surface. Parts subject to wear, such as ram-box liners, lower section of ram, lower section of ram-box and upper section of auxiliary rams, have been made easily renewable. Also, parts subject to burning, such as upper sections of retorts, tuyères, side-wall tuyères and grate bars, can readily be replaced.

Proportioned to the heavy construction of the main part of the stoker, the two-speed gear box is machined throughout. The hand lever *A* on the front of the gear box operates the clutches, by means of which the stoker speed may be changed conveniently without stopping. The shear pin and coupling are at the front of the gear box in sight of the operator, as at *B*.

The design of the ram box allows the depth of the retort to be proportioned to the length of the stoker. This is accomplished by adding tuyères at the top of the retort instead of at the bottom, as was formerly the practice. The advantages of this design are greater capacity per stroke, low crankshaft speed for high capacities, increased agitation of the fuel bed, and more suitable time element for the combusion of the fuel, which tends to give improved operation and efficiency.

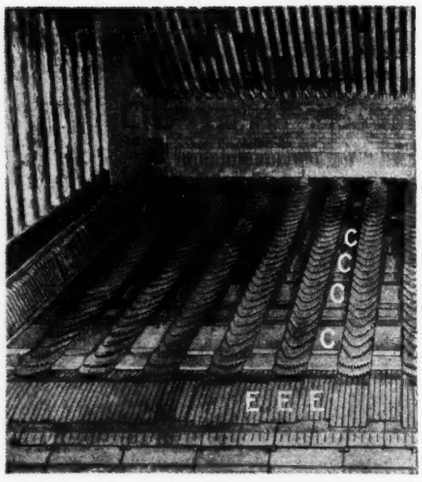


Fig. 2—View of stoker from the rear

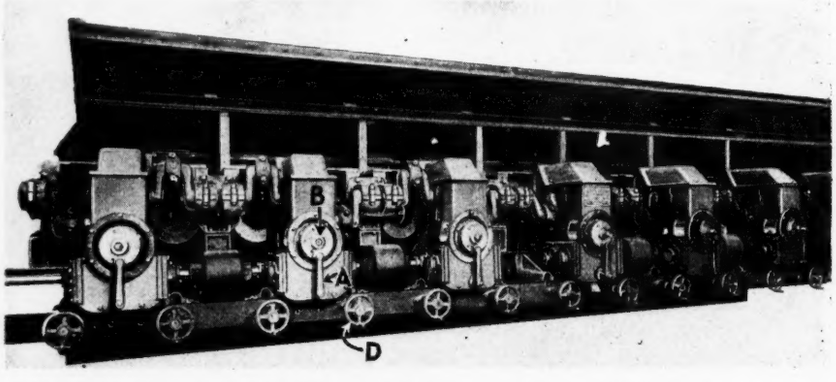


Fig. 1—View of stoker from the front shows accessibility of controls

The design of the auxiliary ram *C* in the retorts is a decided departure from former construction. There are several of these at intervals in the retort, the number depending on the length. They receive their motion from an oscillating link which is operated from a connection to the main ram. The stroke of these auxiliary rams is variable, and separate adjustment may be made on each one. The amount of motion of all auxiliary rams in each retort may be changed simultaneously by means of a handwheel *D* at the front of the stoker.

Grate bars *E* at the end of the stoker have a variable travel and

move in sections. When the main ram is pushing coal into the furnace, the auxiliary rams are moving in the opposite direction and the section of grate bars is moving toward the ash-pit. This action serves to agitate the fuel bed when the fresh charge is being forced in and distributes and levels the fuel bed. Motion of the grate bars at the end of the stoker, being opposite to the direction of the auxiliary rams, serves to clear the ash more effectively from the end of the stoker. Each retort is built up so as to provide for expansion and to minimize the possibility of cracking. The tuyère design gives stream-line flow of air and delivers the greater part of the air sidewise into the retort.

The ashpit may have either grinder rolls or dump grates. Dump grates are usually installed on the smaller sizes, while clinker grinders are standard for the larger sizes of stokers. These rolls are made up of semi-circular cast-iron sections having replaceable teeth and fitted around a square steel shaft which is operated by a pawl-and-ratchet arrangement. Ordinarily, two grinder rolls are furnished in the ashpit, both being reversible and having variable speed.

The ram box, stoker driving mechanism, hopper and retort sides are bolted to the casting which supports the front wall. The entire stoker body subjected to heat is free to expand and cannot cause any disturbance of the front wall. Zone control of air pressure is afforded by the use of separate air compartments extending across the width of the stoker. The amount of air pressure may be suited to the thickness of the fuel bed directly over any particular air compartment. Also, air may be admitted through tuyères, grate bars, side-wall tuyères and either through dump grates or walls of grinder pit.

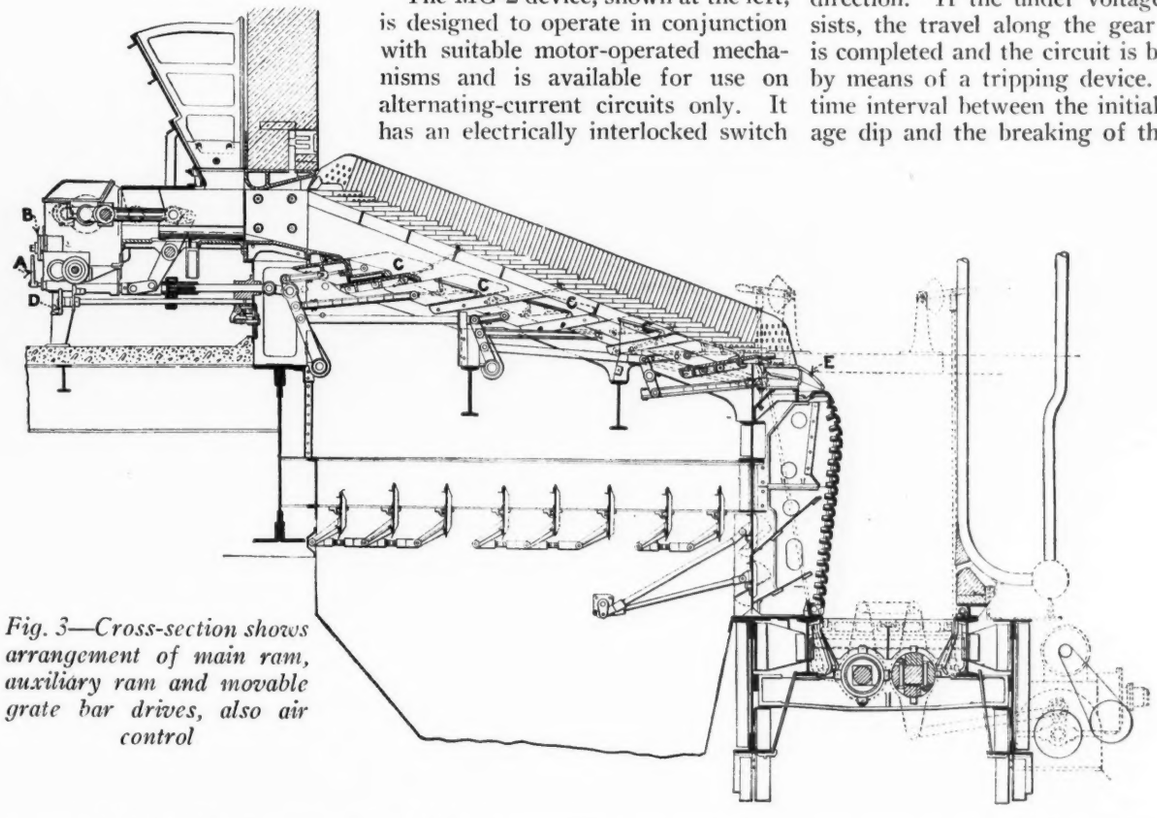


Fig. 3—Cross-section shows arrangement of main ram, auxiliary ram and movable grate bar drives, also air control

Undervoltage Devices Operate After Time Interval

THE undervoltage tripping devices illustrated, recently introduced by the General Electric Company, Schenectady, N. Y., are especially designed to trip the breaker in a circuit only after a suitable time interval, and will not cause interruptions to service when momentary voltage dips occur.

The MG-2 device, shown at the left, is designed to operate in conjunction with suitable motor-operated mechanisms and is available for use on alternating-current circuits only. It has an electrically interlocked switch which is so connected that power cannot be turned on unless the protective unit is in operative condition.

This undervoltage device is especially adapted for motor and synchronous converter service where it is desired to have the oil circuit breaker open when voltage fails or drops below a sertain percentage of normal voltage for an appreciable time.

Breaker tripping devices for alternating-current circuits

Each device contains a motor, a helical spring and a gear train. In operation the motor runs and keeps the spring compressed through the gear train. Upon drop of voltage the spring reverses the motor and runs the gear train in the opposite direction. If the under voltage persists, the travel along the gear train is completed and the circuit is broken by means of a tripping device. The time interval between the initial voltage dip and the breaking of the circuit may be varied by means of adjustments to the gear travel.

The PF-2 undervoltage device shown at the right, is of the solenoid and plunger type with an air bellows for time delay. The time can be varied from approximately one second to one minute. This device can be applied to certain types of oil circuit breaker operating levers.

FROM AMONG THE READERS'

Conducted By L. H. Morrison

Pump Liner Wears.—*We have a steam pump that cuts out the water-cylinder liner about four times a year. The water piston is a plain casting packed with four ½-in. rings held in place by a follower plate.* D. A. W.

Without inspecting the pump it is, of course, impossible to locate the trouble definitely.

Usually, liner scoring is due to one of four causes: The face of the water cylinder has not been machined square with the yoke; the water may be gritty or acid; the water piston may have too tight a fit in the liner, due, frequently, to a distortion of the liner when it was inserted into the pump casting; and finally, the packing may be too large to fill the packing space without undue squeezing by the follower plate, which forces the fibrous packing against the liner.

Meaning of Boiler Rating.—*What is the meaning of "per cent rating" in a boiler. Suppose you were told the boiler heating surface was 20,000 sq.ft. designed to evaporate 250,000 lb. per hour, what would the rating be? Explain also the English way of rating boilers as compared with American way.* G. B. S.

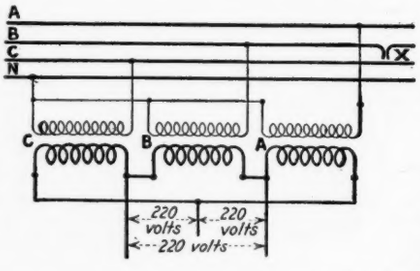
The statement given of heating surface and steaming rate is in accordance with English practice and the term per cent of rating appears in connection with this practice. In this country boilers are rated in a different manner, entirely arbitrary and illogical. In 1876, in connection with the Centennial Exposition, a congress of engineers defined the boiler horsepower as the evaporation of 30 lb. of steam per hour at a pressure of 70 lb. gage from feed water at a temperature of 100 deg. F. This was equivalent to the absorption of 33,460 B.t.u. per hour.

Boiler practice, following 1876, gradually crystallized to the provision of 10 sq.ft. of heating surface for the absorption of this quantity of heat and, accordingly, the custom arose of stating the horsepower of a boiler on this basis; that is, if a boiler had 20,000 sq.ft., it was arbitrarily said to be a 2,000-hp. boiler. If it actually delivered 2,000 hp.—that is, if it evaporated approximately 60,000 lb. of steam per hour—it was said to be operating at 100 per cent of rating. If it was evaporating steam at any other rate, this was expressed as a percentage of approximately 60,000.

American practice has come to recognize the inappropriateness of this method of rating boilers, and engineers now state the size of a boiler in square feet and express its rate of steaming in pounds per hour or in thousands of B.t.u. per hour.

Transformers Supplied from Two Lines.—*There is a bank of transformers on our power system that can be fed from two sources. Normally, the oil switch shown in the figure is open and the transformers are supplied from the line coming in from the right. If line B were to open at X, as shown in the figure, would it be possible to close the B pole of the oil switch and operate the transformer while the break in line B was being repaired?* G.M.

This arrangement will work provided both lines are a part of the same system. There seems to be no reason why



all three poles of the oil switch should not be closed. This should give a better balance to the line voltage than when only one pole is closed. When the break is closed at X, there is the possibility of a considerable power flow, therefore care should be exercised not to open the line after it is closed, or a dangerous arc may develop.

Pressure Drop in Steam Line.—*Steam at 130 lb. gage boiler pressure is supplied through 600 ft. of 6-in. pipe to a 14x36-in. Corliss and a 10x18-in. high-speed engine. What pressure drop should one expect if the line is covered with two inches of asbestos felt covering?* G.H.B.

You do not state the power developed by the engines, so I will assume that the 14x36 engine runs at 125 r.p.m. and develops 125 hp., and that the 10x18 runs at 200 r.p.m., developing 60 horsepower.

The steam consumption of the 14x36 engine is probably 26 lb. per hp.-hr., calling for 3,250 lb. per hour. The small engine will use about 35 lb. per i-hp. hr., or 2,150 lb. per hour. The total hourly flow is then 5,400 pounds.

It has been found that the pressure loss due to the steady flow of a fluid through a pipe varies with the density of the flow, is proportional to the length of the pipe, decreases as the pipe diameter increases and increases with the roughness of the pipe surface, and also increases nearly with the square of the velocity. A formula much used is:

$$\text{Pressure drop} = \frac{174.2F\,M^2V\,L}{d^5} \text{ where}$$

M = lb. of steam per sec. = 1.5 in this case;

V = Volume per lb. of steam = 3.11 cu.ft. at 130 lb. gage;

L = Pipe length in ft. = 600;

d = Actual pipe diameter in inches = 6.06, but a value of 6 will be used;

$$F = \text{A factor} = 0.0027\left(1 - \frac{3.6}{d}\right) = .00432.$$

Substituting the proper value, we have

$$\text{Pressure drop} = \frac{174.2 \times .00432 \times 1.5^2 \times 3.11 \times 600}{6^5} = .04 \text{ lb. per sq.in.}$$

Even without the covering the drop would not be appreciably greater, although the heat loss due to condensation would be large.

Temperature Correction for Fuel Oil.—*We are buying oil by the tank car, and as the temperature in winter is low, I wonder if there is any way to learn how much fuel shrinks at low temperatures. We have a correction table for the oil level in the tank.* G.B.S.

Oil will suffer a reduction in volume of 0.04 per cent per deg. of temperature drop. Since 60 deg. is taken as the standard atmospheric temperature, a temperature of 30 deg. would cause 10,000 gal. of oil to suffer a shrinkage of

$$10{,}000 \times \frac{0.04}{100} \times (60 - 30) = 120 \text{ gal.}$$

Condensation in Steam Engine.—*I have heard it claimed that a compound engine has less cylinder condensation than a single engine, as the exposed surface is greater. Is this true?* F. A. B.

If a simple Corliss engine operates with the same number of expansions as does a compound Corliss engine—that is, if the terminal expansion at the end of the stroke of the simple engine is equal to the terminal pressure at the end of the expansion stroke of the low-pressure cylinder of the compound engine—then the simple engine will have a greater amount of condensation.

This is because the temperature range in the one cylinder is high, being the difference between the temperatures corresponding to the initial and the terminal pressures, while in the case of the compound engine this same temperature range is divided between the two cylinders.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

WHAT is surface tension and does it influence boiler foaming?
C. S. R.

SURFACE tension can best be explained by a simple illustration. We know that steel is heavier than water and ordinarily will not float, but we find that if a dry steel needle is gently placed on the surface of a glass of water it will float. This can easily be verified, and it will be noticed that there is a slight depression or dent in the surface of the water under the needle.

The supporting force which keeps the needle from sinking is surface tension. Thus surface tension may be regarded as the opposition which the surface of a liquid presents against the entrance into it or the escape from it of any foreign material. Its effect is much as if a thin flexible membrane were stretched across the surface.

Now for its effect on boiler foaming. If we take a glass of pure water and heat it to the boiling point, small bodies of steam will form at the bottom and rise through the liquid to the top. Here surface tension tries to keep this steam from escaping and a bulge appears in the surface as the steam rises under this imaginary flexible membrane which we call surface tension. Thus a bubble is formed which, in the case of pure water, quickly breaks and the steam passes out.

If we now increase the surface tension of the liquid by adding some soluble salts or, better yet, by putting a small amount of oil on the surface, the bubbles will not burst instantly. The strength of the film has been increased and a coating of bubbles persists on the surface during boiling.

This is the condition that exists in a boiler. Owing to the impurities dissolved or suspended in most boiler feed water, it is treated with caustic or some other material to check corrosion and lessen or soften scale. Best practice generally demands an alkaline condition, and most alkalies are more or less of a soapy nature. Thus this treatment, although important, does generally increase surface tension. Surface tension is greatly increased if engine oil by some means finds its way into the boiler through condensate pipes or other means. Such oil floats on the surface, forming a film.

In a boiler the amount of bubbles that will be formed under such conditions depends on the rate of steaming. If a sudden demand or load is thrown on the boiler, bubbles will be formed in large quantities and the boiler will foam violently. A reasonable amount of foaming does no harm, but if foaming is violent, bubbles and water may be carried over with the steam into the steam lines, causing a boiler surge.

Oil will greatly increase the surface tension, and it can thus be seen why it is important that there be no leakage of oil into the boiler feed water system in the plant. CHARLES A. BARTLETT.
Palmer, Mass.

ACCORDING to the molecular hypothesis all molecules exert on one another an attractive force. The molecules on the surface of a liquid are not attracted equally from all sides. Their attraction is therefore unbalanced. The attraction of the molecules below the surface on these surface molecules exerts a pressure that is similar to that of an elastic skin exerting a pressure on the interior of the liquid mass. This skin tension, or pressure within the liquid mass, is called the surface tension of the liquid.

When water is heated the temperature rises, and unless the water has been carefully freed from dissolved gases, as the temperature approaches 212 deg. F. small bubbles are formed on the sides of the container. Under standard conditions of pressure, the bubbles are formed rapidly, rise to the surface and burst. The explosive force with which these bubbles break through the surface is due to the surface tension, or skin tension of the surface.

Water and other liquids under atmospheric pressure in a clean vessel may be raised several degrees above the boiling point, and when a bubble forms it will expand and burst explosively. Is it not reasonable to suppose that to some extent this might be due to the pressure of the surface tension?

If the steam rises too fast from the surface of the water, it carries water with it in the form of a fine spray. This should be controlled in the design of the boiler. If this happens the boiler is said to prime.

If the feed water is dirty, this priming will be more violent and we say the boiler is foaming.

It is logical to say that the surface tension of the water surface affects the rising steam bubbles and causes them to burst explosively as they break through the surface. On the other hand, this surface tension decreases as the temperature rises, which would cause this influence to decrease.

Feed waters that carry in solution salts, organic matter, oils or fats, are undesirable for boilers. Oils and fats are known to increase boiler foaming. Any of these salts or fats that increase the surface tension of the solution will increase foaming. The surface tension of soapy water is higher than pure water and it is the surface tension that holds the soap bubble together. [Soapy water has a lower tension than pure water.—EDITOR.]

The deduction is that surface tension has a direct influence on foaming. Anything in the feed water that increases the surface tension will make boiling more violent, help make the bubbles hold together and generally increase the tendency to carry over more spray and water.

Sheboygan, Wis. G. A. GLICK.

A Question for Our Readers

WOULD there be any difficulty in paralleling a direct-current motor alternating-current generator set, rated at 125-kva., with a 100-kva. turbine-driven alternator, the governor of which is not adjustable from the switchboard? The speed of the motor-generator set can be controlled by a rheostat in the motor's field circuit. Would it be necessary to increase the speed of the motor above that of the turbine after they are connected in parallel? With the turbine unit used as a synchronous condenser, could the power factor of the motor-driven generator be increased to 100 per cent? W.J.D.

Suitable answers from readers will be paid for and published in the March 19 issue.

1,200-Lb. Pressure

. . . A DOLLAR SAVER . . .

By Edwin Jowett
Vice-President
Kansas City Light & Power Company

Following up a line of study made by company engineers in 1922-23, a 1,200-lb. pressure installation has been "superimposed" in the 300-lb. equipment of the Northeast Station of the Kansas City Power & Light Company. Careful analysis indicates that the additional fuel savings will be about three times the additional fixed charges, as compared with a low-pressure extension of equal capacity. This detailed description and analysis is slightly abridged from a paper presented last week at the Midwest Power Conference, Chicago.

THE Northeast Station, which has for nearly eight years carried the entire system load of the Kansas City Light & Power Company, was designed originally by Sargent & Lundy of Chicago, and the first 23,000-kw. unit put into service in the fall of 1919. Since that time it has had a continual expansion, under the direction of the company's own engineers, until at the present time it contains 140,000 kw. of generating capacity. While the initial steam pressure of 300 lb. has been maintained throughout all additions, many other changes and improvements have been made both in new and old equipment, which, along with improving load factor have reduced the B.t.u. per kilowatt-hour of the station from about 21,000 to 16,700. By the addition of radiant-heat booster superheaters the operating steam temperature has been raised from 650 deg. to about 700 deg. Original boilers were fired with natural-draft type chain grates, later boilers with forced-draft chain grates and within the last year one boiler has been converted to unit-type pulverized-coal firing.

It was evident that, with the existing steam pressure and temperature, practically no further substantial improvements could be made in the economy of the station.

The plant contains three 23,000-kw. turbines and two 30,000-kw. units served by twelve 13,500-sq.ft. boilers. With a limitation of approximately 250 per cent boiler rating as the economical load with the fuel used, the present plant was lacking in boiler capacity. The existing building contained space for four additional boilers, at least two of which would have been required for the 1928-29 peak. Accordingly, following up a line of study made by the company engineers in 1922-23, a decision was reached to install two high-pressure boilers and a turbine which would exhaust through reheaters to the station 300-lb. header. In this manner, the desired additional boiler capacity would be obtained, along with some additional turbine capacity.

When the original studies were made, it became evident that the installation of the equipment would have to be delayed until the minimum load on the system had grown to a sufficient amount to permit operation of the high-presure equipment and its complement of low-pressure turbines at a very high daily load factor. This point was reached in the fall of 1928, shortly after which the high-pressure equipment was ready for operation.

An operating pressure of 1,200 lb. at the turbine throttle and a total temperature of 725 deg. was chosen for the turbine. The pressure was but little above that which had already been tried at Boston and Milwaukee and the temperature such that the expansion to the present station header pressure through the turbine would give steam of a temperature but slightly above the saturation point. The size of the turbine chosen was such that its output, together with that of the present turbines using its exhaust steam, would practically meet the minimum load requirements, and at the same time could normally be supplied with steam from two boilers of a size that could be fitted into existing vacant boiler bays. While two boilers will normally be in service to carry full load on the turbine, the furnaces and fuel-burning equipment are so proportioned that 7,500-kw. load can be carried on one boiler.

The investment costs for this particular installation were considered more as the difference between the installation cost of two boilers of 300-lb. pressure and equal capacity and two high-pressure boilers with reheaters. The turbine gave additional plant capacity at practically the same cost per kilowatt as a 300-lb. turbine, condenser and its auxiliaries. Furthermore, it was possible to locate this high-pressure turbine in the boiler room adjacent to the high-pressure boilers, where the addition of a like capacity of 300-lb. turbine would have necessitated an expensive addition to the turbine room.

The proximity of the high-pressure turbine to its boilers and reheaters helped materially to reduce the additional cost of high-pressure piping over 300-lb. piping. It also served to hold down the pressure losses through the steam connections. The design of the turbine and generator was such that no trouble is anticipated from dust of the boiler room.

From a close analysis of the probable system load and the proposed equipment, it was concluded that the following operating schedule could be followed in 1929:

Expected kw.-hr. generated on 1,200 lb. unit (82.5 per cent L.F.) (Based on expected turbine and boiler outage and load conditions)	72,200,000
Expected kw.-hr. generated on present units with exhaust steam from h.p. unit	245,600,000
Expected kw.-hr. generated on remaining present units	212,401,400
	530,201,400
On the above basis, the consumption would be:	
Average B.t.u. per kw.-hr. on 1,200-300 lb. combination (Assuming full load on h.p. unit)	13,810
Average B.t.u. per kw.-hr. on rest of 300 lb. units (Assuming the same as for 1928 performance)	16,800
Composite average B.t.u. (net)	14,970

An analysis of the relative costs of 1,200-lb. and 300-lb. installations afforded a means of determining whether the saving in fuel would justify the investment. In order to put the two installations on a strictly comparable basis, both were figured on the most economical size equipment for this station and reduced to unit costs. The high-pressure job furnished 10,000 kw. of electrical energy and steam for a total of 45,000 kw. The boilers for the 300-lb. unit would be capable of furnishing steam for 45,000 kw. and the

turbine would be a 30,000-kw. unit. From the unit costs so figured, the comparision was worked out for 10,000-kw. electrical output and sufficient boiler capacity for 45,000 kw.

A summary of the costs is as follows:

10,000-KW. TURBINE INSTALLATION	
1,400-lb. boilers (steam for a total of 45,000 kw.)	$1,342,138
1,200-lb. turbine	307,246
	$1,649,384
300-lb. boilers (steam for 45,000 kw. total)	918,000
300-lb. turbine	335,000
	$1,253,000

From the foregoing, the high-pressure installation costs $396,384 more than the 300-lb. installation of like capacity. This is an increase of 31.6 per cent. It must be borne in mind that these figures apply only to the particular job in question. If fixed charges at 13.25 per cent are figured on the difference between these two investments, the annual saving from the operation of the high-pressure equipment must at least equal 0.1325 × $396,385, or $52,520.

As previously shown, it is estimated that the heat consumption of the station will be lowered from 16,800 B.t.u. per kw.-hr. to 14,970 B.t.u., or 1,830 B.t.u., by the operation of the high-pressure equipment. For the annual output of 530,201,400 kw.-hr., and with fuel at 67,000 B.t.u. for one cent, this saving in fuel will result in an annual reduction in cost of $144,700. This is nearly three times the fixed charges on the difference in cost of the two installations.

Whether or not the new equipment will involve higher maintenance is problematical and can be determined only by time. The practically completely water-walled furnaces of the two high-pressure boilers should result in lower furnace maintenance than the old masonry-lined furnaces.

A description of the various parts of the equipment is given below:

GENERAL OPERATING CONDITIONS	
Maximum pressure for which boilers are designed	1,400 lb. gage
Normal operating drum pressure	1,280 lb. gage
Pressure at turbine throttle	1,200 lb. gage
Temperature of steam at turbine throttle	725 deg. F.
Back pressure at turbine exhaust at full load	315 lb. gage
Superheat in exhaust at full load	40 deg. F.
Pressure steam out of reheater	290 lb. gage
Temperature steam out of reheater	700-725 deg. F.

Bent-Tube Boilers Selected

Many studies and investigations were made on the two general types of high-pressure boilers now in service in this country. While it appeared that both types were working out quite well, several points seemed to favor the bent-tube boiler in the minds of the company's engineers.

The largest boiler that could be installed in the existing bays contained about 17,000 sq.ft. Two boilers of this surface would be sufficient to carry full load on the turbine at an economical boiler rating. However, even for boilers of this size many changes had to be made in the existing steel framework of the building.

It was the original intention to fire the boilers with forced-draft chain grates, but it was found next to impossible to get sufficient grate area under the boilers to carry maximum load with the low grades of bituminous coals used at the station. Stokers of greater width than had yet been built would have been required and manufacturers were reluctant about building them.

An experimental installation of two unit pulverizers firing a 13,500-sq.ft. boiler had been in operation in the station about six months at that time. To date it had proved satisfactory from the dependability and efficiency viewpoints. Largely on the performance of this installation it was decided to follow the same general scheme for the two high-pressure boilers. The plant is situated away from the business and residence district, so that the problem of removal of fly ash did not influence the decision. It was possible to install a water-cooled furnace of sufficient size to keep the combustion rate down to 20,000 B.t.u. per cubic foot of furnace at maximum rating and about 17,000 B.t.u. at normal rating. This is based on a furnace volume of 15,670 cubic feet.

The furnace below the burner line is made up of fin-tube water walls on the front and back, and bare tubes on 7½-in. centers on the two side walls, all tubes being 3 in. O.D. by ⅛ in. thick. Immediately back of the side-wall water tubes are the reheater elements made up of single loops of 1¾-in. O.D. tubes about 17 ft. 6 in. long. Secondary air ports are provided in the front wall with independent control in horizontal rows. A typical form of water screen is provided at the bottom of the furnace with tubes arranged on 12-in. centers.

Nine 8-in. forced-blast Lopulco burners fire downward at a slight angle with the vertical through a tile-backed, water-cooled arch. These water-cooling tubes

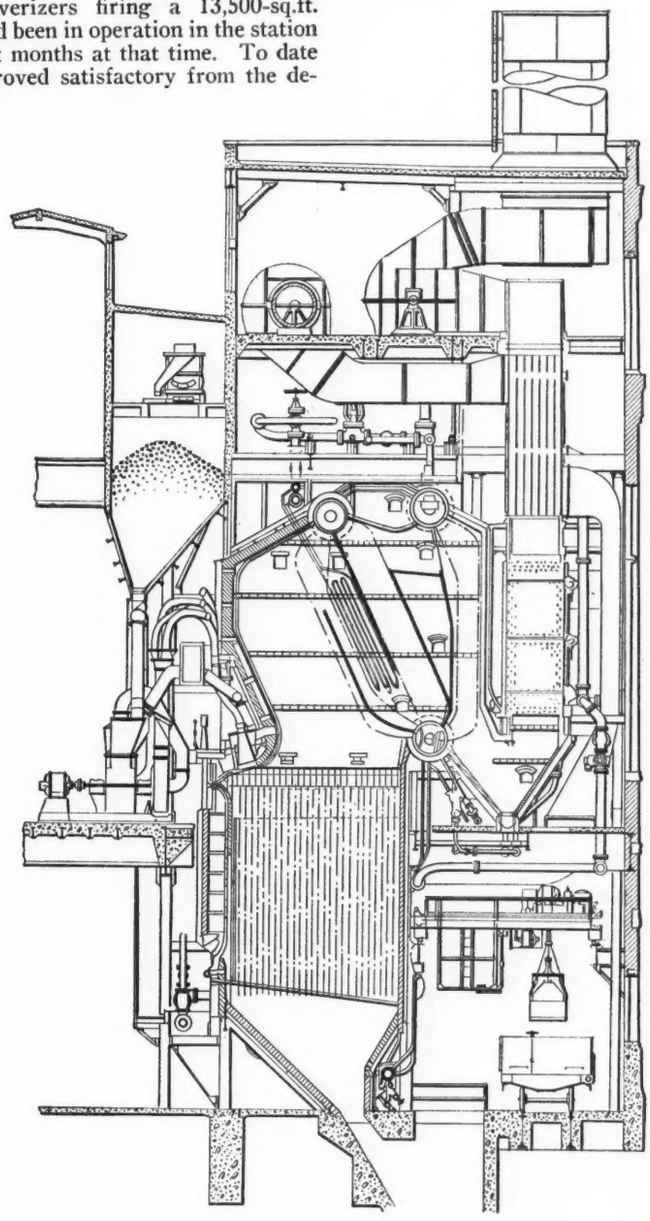


Fig. 1—Cross-section through high-pressure boiler, economizer and air heater

bend upward and form the front wall above the burner arch and also the top arch, which is likewise tile-backed. These backing tile are hung on independent cast-iron hangers and do not rest on the tubes.

The upper side walls are made of firebrick and insulating material. The

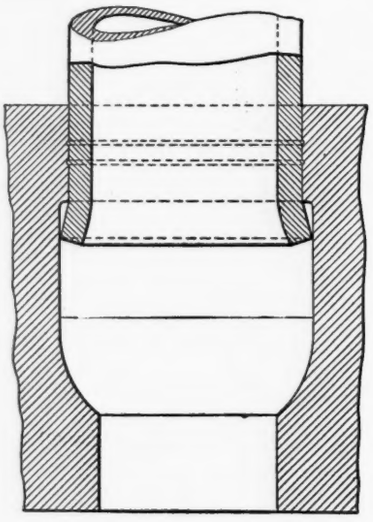


Fig. 2—Method of rolling boiler tube in header

entire furnace, ash hopper and boiler is steel encased.

An effective means of providing these water walls with water has been employed. A large header at the lowest part of the furnace at the rear is supplied with water from the lower drum by fifty-two 3-in. downcomer tubes outside of the furnace. This header is a forging 18 in. O.D. by 3 in. thick and 36 ft. 8 in. long. The rear water-wall fin tubes rise directly from this header to the lower drum, passing through connecting tubes into one row of the first bank boiler tubes, thence to the front steam-liberating drum.

The water-screen tubes come out of the back of this header, pass between the rear water-wall tubes and across the furnace to the lower front header; thence the circulation is through the front-wall fin tubes to an intermediate header. From this header the arch and upper front-wall tubes carry the water on up to the front drum. Eight short tubes from each extended end of lower rear header supply water to the lower side-wall headers. The water rises through the side-wall tubes to upper side-wall headers, thence through twelve external riser tubes on each side of the boiler to an extension of the front drum outside the furnace casing.

The ash-handling arrangement is similar to that employed in the other part of the plant. A sloping furnace bottom empties into a more or less shielded water-sealed pit. From this pit the ash is removed by a clam-shell bucket and bridge crane, also shown in the cross-sectional view.

The two high-pressure boilers are of the three-drum Stirling type so baffled that the gas makes three passes in traversing the boiler. An Elesco convection type primary superheater is located between the first and second passes. The drums are seamless steel forgings 40 in. inside diameter and 5¼-in. thick. The lengths of the three drums vary from 29 ft. 8 in. to 34 ft. 2 in. The heaviest drum weighs about 77,000 lb. All tubes in the boilers are 3 in. O.D. by $\frac{5}{16}$ in. thick.

These boilers do not employ the standard Ladd method of feed. Con-

GENERAL BOILER DATA

Normal boiler evaporation per hour		170,000 lb.
Maximum boiler evaporation per hour		200,000 lb.
Sq.ft. heating surface in boiler		16,950
Sq.ft. of water screen (plain tubes)	330	
Lower front finned tubes	415	
Upper front plain tubes	670	
Rear finned tubes	765	
Two sidewalls—plain tubes	870	
Total wall, surface, sq.ft.		3,050
Reheater surface each boiler, sq.ft.		470
Primary superheater surface, each boiler		2,650
Safety valves each boiler, four 4 in., one 2 in.		

trary to what was first planned, the water is fed direct to a feed box in the upper rear drum. Steam is taken off of the rear drum through two 6-in. nozzles studded and step-jointed to the drum. Each outlet is provided with a steam purifier drained externally.

Water columns are of forged steel with flat glasses mica protected.

Boiler Auxiliary Equipment

Each boiler is provided with three impact-type mills with a capacity of 15,000 lb. each of bituminous coal per hour containing 15 per cent moisture. The primary air entering the mills will be heated to any desired amount up to 400 deg. The mills are direct-connected to 200-hp. motors. Heater secondary air is admitted at the burner, and tertiary heated air through the front furnace wall below the burners.

Each boiler is provided with a fin-tube economizer of 10,891 sq.ft. of effective heating surface. The tubes, which are 2½ in. O.D., No. 2 gage, are arranged in staggered rows. The economizer is designed for a working pressure of 1,490-lb.

Water will be fed to the economizer at a temperature of 210 deg. F. and will leave at a temperature varying from 319 deg. to 324 deg., depending on the boiler rating.

The gas, after leaving the economizer on each unit, passes up through a plate-type air heater having 39,270 sq.ft. of heating surface. The air heater is typical in every way of this kind of equipment. A final air temperature of about 425 deg. is obtained, while the leaving gas temperature is about 330 deg.

The induced-draft fan on each boiler is designed for a maximum draft of 10 in. water and is driven by a 450 hp. motor. The forced-draft fans are designed for 7½ in. and are driven by 225-hp. motors. One short steel stack supported on the building steel serves both boilers.

Two motor-driven boiler feed pumps, each of sufficient capacity to handle both boilers, have been provided. Each pump is of 800-gal. per min. capacity against a total discharge head of 1,500 lb. The pumps are provided with water at their suction from present station boiler-feed pumps at 350-lb. pressure. The pumps operate at 3,550 r.p.m., and are direct-connected to 900-hp. induction motors. The pump discharge pressure is controlled ahead of the economizer by a differential pressure regulator which maintains a constant differential between the drum pressure and the water entering the economizer. Its chief purpose is to protect the economizer against the high shutoff pressure of the feed pumps and, incidentally, to improve operation of the automatic feed-water regulators.

The turbine generator is of the combined impulse reaction type. The gen-

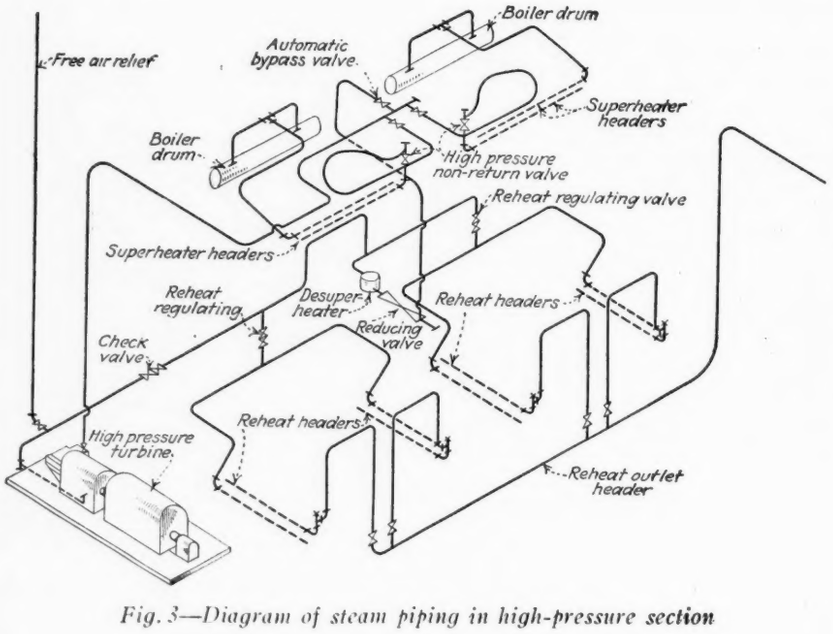


Fig. 3—Diagram of steam piping in high-pressure section

erator is rated at 10,000 kw. at 80 per cent power factor. The turbine cylinder is machined from steel forgings, as is also the steam chest, which sits alongside the unit. The throttle valve and single governing valve are in this chest. Four flexible pipes connect the steam chest to the turbine cylinder. The cylinder is supported in a novel manner from the exhaust casting suspended by steam-heated steel links from stationary brackets attached to the foundation. This type of support allows free cylinder expansion and at the same time maintains a fixed center line regardless of what pipe strain might be imposed on the exhaust casting by the exhaust pipe.

The impulse element of the turbine consists of two rows of revolving blading and one row of stationary blading made of stainless steel. This is followed by fourteen rows of reaction blading made of pure nickel. All blades are shrouded and of the end-tightening type. A stainless-steel built-up nozzle block expands the 1,200-lb. steam down to 845 lb. before it enters the first impulse blades.

The dummies are of a special design, so that should any rubbing occur, either in the dummy packing or in the blading, the area of the contact is exceedingly small and the intensity of rub very light.

The high-pressure gland has the same arrangement of end tightening strips as the high-pressure dummy. The gland at the exhaust end is fitted with radial contact strips because of their remoteness from the thrust bearing.

A Kingsbury thrust bearing with ready handwheel adjustment of the axial position of the rotor is provided. Stops for limiting the movement of the thrust are provided so that starting and running position are readily found.

When operating under the conditions hereinbefore described, the turbine will have a water rate varying from about 34 lb. per kw.-hr. at full load to 45 lb. at half load. The superheat in the exhaust at the above loads vary from 22 deg. to about 60 deg. respectively.

All high-pressure steam joints, 6-in. and above, are Sargol type except those connecting immediately to the boilers, superheaters and turbine. These particular joints, as well as all steam joints between 6 in. and 1½ in., are small tongue-and-groove. Steam joints below 1½ in. are large male-and-female. Only lap flanges are used, all tongue-and-groove or male-and-female facings being made in the lap of the pipe. All joints in the boiler feed pipes are small tongue-and-groove. In most cases Norway iron gaskets are used in the tongue-and-groove and male-and-female joints.

Feed Water

In the present part of the plant no evaporators or feed-water treating was used; complete deaeration of the feed water has, however, been effected for several years, and no trouble from oxygen pitting has been experienced. The undesirability of using untreated makeup in the high-pressure boilers, even in as small a percentage as 2-3 per cent, was realized. The general arrangement of the station piping and heat balance was such that an installation of evaporators would have been difficult and expensive. An arrangement has been worked out for feeding the high-pressure boilers entirely on condensate. A hot-process lime-and-soda-ash treating plant has been installed for treating the makeup for the low-pressure boilers. It is possible that an after treatment with trisodium phosphate may be added. Special precautions have been taken to reduce condenser leakage to an absolute minimum and condenser leakage recorders have been installed on all condensers.

Centralized manual control of the boilers is provided. It is so arranged that such parts of it as may prove desirable, after some experience with the operation of the equipment has been obtained, can be made automatic.

Recent Publications

Finding and Stopping Waste in Modern Boiler Rooms. Third edition. Published by the Cochrane Corporation, Philadelphia, Pa. Cloth; 5x7 in.; 788 pages. Price, $3.

THIS edition of "Finding and Stopping Waste in Modern Boiler Rooms" is larger than previous volumes and has been revised to contain tables, charts and other material, selected from the latest books, articles in technical papers, United States Bureau of Mines publications and transactions of engineering societies. To those engineers who have used the previous editions, no further recommendation is necessary.

Boiler-plant proportioning and management, which in previous editions was treated in a separate section, is made part of the chapter on boiler efficiency and testing. A new section deals with feed-water heating and conditioning. Under the subject of feed-water heating are discussed ideal cycles, feed balancing and auxiliary drives, and a large number of sample central-station heat-balance diagrams are presented. Under the subject of feed-water conditioning are discussed such subjects as boiler scale and its prevention, rapid examination of water, practical interpretation of analyses, chemical treatment, priming and foaming, deaëration, and corrosion and embrittlement of boiler plate.

The section on combustion has also been increased. In particular the discussion of chain-grate, overfeed and underfeed stokers has been considerably extended and the data on powdered coal have been increased and brought up to date.

Hydraulic Laboratory Practice. Edited by John R. Freeman, Consulting Hydraulic Engineer. Published by The American Society of Mechanical Engineers, 29 W. 39th St., New York City, 1929. Cloth; 8½x12 in.; 996 illustrations; 868 pages. Price, $10.

At this time, when there is a pressing need for a national hydraulic laboratory in which to work out the solution of the problems involved in development and control of our river systems, this book comes as an invaluable contribution. It comprises a translation, revised to 1929, of "die Wasserbaulaboratorien Europas," published in 1926 by Verein Deutscher Ingenieure. There are also included descriptions of other European and American laboratories and notes on the theory of experiments with models.

In the preface and foreword the editor tells how the work was conceived when he was in Europe inspecting river-structure and waterwheel laboratories. He became so impressed with the great practical results being accomplished, that he urged Dr. Conrad Matschoss, secretary of the German Society of Engineers, to invite the skilled hydraulicians in charge of these laboratories to join in a series of monographs in which each should describe the laboratory in his charge, these monographs to include some of the authors' principal researches, showing their success in the use of models. Also, there should be set forth some of the abundant proof, accumulated by comparisons between model tests and full-size structures, channels or waterfalls, which show that streams behave very much in nature as in their small laboratory counterparts, when these are wisely proportioned and skillfully managed.

This suggestion was carried to a successful conclusion and forms seventeen chapters of the book, to which an even greater number of authors contributed. To this work have been added seventeen appendixes dealing with various features of hydraulic laboratories in Europe and America. Included in each chapter is a bibliography of technical literature, which adds materially to the value of the text. There are also presented articles dealing with tests made on models and how model tests check up with the results on full-size structures.

In addition to being responsible for the translation and editing of the work, Mr. Freeman has made a number of contributions as an author. The wide variety of the treatment representing the experience of so many prominent hydraulic engineers, makes the work an outstanding contribution to hydraulic-engineering literature, one that is of interest to both experimental and designing engineers.

NEW METALS NOW USED

For Modern High Pressures and Temperatures

UNTIL recently the materials used in power plants, exclusive of the building, were cast iron, wrought iron, steel and refractories, with some limited use of bronzes, brasses and bearing metals. At present, with the higher temperatures and pressures used, many of the metals that were formerly acceptable are now no longer used or have been relegated to unimportant service. Power plants are now in a state of transition to the use of special metals and alloys, such as that experienced by the machine and automotive field some years ago.

Cast iron was formerly used for many furnace parts, particularly tuyeres, and as casings for such units as pumps and turbines. At present its use is decreasing rapidly, in spite of its outstanding asset of cheapness, because in most instances it possesses no property that warrants its choice over other materials. This does not mean that cast iron will disappear from use, as in service at ordinary pressures and temperatures it has a large field. Also it possesses the characteristics of resisting oxidation and corrosion to a greater degree than ordinary steel.

Cast Iron Grows Under Temperature

A major characteristic of cast iron is growth under temperature. Cast iron containing less than 0.50 per cent silicon and approximately 1 per cent of manganese with about 3 per cent of carbon will not grow; but iron of such composition is not machinable. Marked improvements in the composition of cast iron have been made through the addition of alloys, these improvements being largely as to strength and machinability rather than in any properties making the material particularly suitable for power plants.

Formerly, wrought iron was extensively used for boiler tubes, but now has little application for this purpose. It is still used somewhat as tube stock for economizers, because it is felt by some to possess a greater resistance than steel to the corrosive conditions existing in this equipment.

Plain carbon steel is used in power plants in three forms—cast, rolled and forged.

Cast steel is used extensively for valve parts and fittings. Some of these fittings weigh as much as 10,000 lb. and hence present real manufacturing difficulties. All the important steel castings used in power plants are made by the electric furnace process and are usually furnished in the annealed or normalized condition. Designers of power plants can be particularly helpful if they will observe certain general precautions in the design of castings, among which are: (1) The use of suitable fillets; (2) the maintenance as far as possible of the same thickness of metal throughout the cross section of the castings; (3) the control of the total weight of the casting so as to keep it as much under 10,000 lb. as possible.

Abstract of a paper delivered by A. E. White, professor of metallurgical engineering and director of the department of engineering research, University of Michigan, Ann Arbor, Michigan, before the Fourth Midwest Power Engineering Conference, Chicago, Ill., Feb. 12 to 15, 1929, entitled, "The Metals in Power Plants."

Rolled steel is largely used in buildings and for reinforcing in concrete for foundations or other purposes. It is also used in the form of tubes of both the welded and seamless pipes. The seamless tube is felt to be safer than the welded by most users, although for many purposes the welded is acceptable. At present a very high grade of welding is being done.

Seamless pipes can be obtained up to about 24 in. in diameter in almost any desired length. This seamless tubing can also be obtained in alloys such as stainless steel and chrome nickel. These tubes are used for such purposes as boiler tubes, economizer tubes, superheaters and fittings.

The major uses of forged steel in power plants are for turbine shafts and disks. The forging operation must be performed so as to prevent the development of cracks in the metal. It is the writer's opinion that where possible an improvement is brought about by upsetting. Likewise, particularly in the case of large forgings, it is important to bring the forging to heat slowly, so that the metal may be the same temperature from the center to the surface.

How Alloy Steels Are Used

For the sake of brevity seven alloy steels alone are considered in this paper. These are: 3½ per cent nickel; low chromium, low nickel; low chromium, low tungsten; 8 per cent chromium, 8 per cent tungsten; stainless steel containing 12 to 14 per cent chromium; Enduro containing about 18 per cent chromium; and chromium nickel steel containing 19 per cent chromium and 8 per cent nickel.

The 3½ per cent nickel steel is used mainly for turbine disks and in some cases for turbine shafts. It is preferred to plain carbon steel because of its higher strength and greater resistance to oxidation. The Chapman Valve Manufacturing Company has advocated chromium nickel steel for castings for some time. Its use gives castings of higher strength than does plain steel. Mr. Malcolm, metallurgist for the company, was the first to bring to the attention of the public the value of a low chromium, low tungsten alloy for high-temperature service. Investigations in the writer's laboratory indicate that an alloy of 8 per cent chromium and 8 per cent tungsten has stability characteristics greater than those of the low chromium, low tungsten alloy; although it must be recognized that the greater the amount of chromium and tungsten present the greater the difficulty with which forming and machining operations can be performed.

Stainless Steel Used for Turbine Blades

Stainless steel is used quite extensively for turbine blades. This is a metal carrying from 12 to 14 per cent chromium and under 0.1 per cent carbon. As turbine blades are one of the crucial parts in the power plant, considerable study has been given to the proper selection and design of this equipment. None of the manufacturers feels that the problem has been entirely solved, though with recent improvements in design and greatest care in the selection of stock less difficulty should be encountered than has been the case in the past.

With higher operating temperatures a suitable material for use in super-

heaters has been sought. Plain carbon steel is recognized as unsatisfactory and stainless iron tubes and stock made of Enduro have been tried. This latter material unfortunately appears to develop brittleness when held at temperatures around 1,000 deg. F. for a long time, and its use has therefore been discontinued. An alloy made up of about 19 per cent chromium and 8 per cent nickel is now being used, for this particular composition manifests superior stability at elevated temperatures as well as great resistance to oxidation.

Non-Ferrous Metals Widely Used

Large quantities of non-ferrous metals are used in power plants, chief among which are copper, lead, brass, bronze, babbitt and monel.

Copper is employed mainly in generators and for transmission lines, and is used in a high state of purity.

Lead is used in large quantities as a covering for transmission cables. For this purpose it is used either as the pure material or as an alloy carrying small quantities of antimony or tin.

Brass is used in large quantities in condensers. One brass, known as Muntz metal, is composed of about 62 per cent copper and 38 per cent zinc. Another type consists of 70 per cent copper and 30 per cent zinc; and a third, known as Admiralty, is composed of 70 per cent copper, 29 per cent zinc and 1 per cent tin. Consideration is also being given to nickel and adnic tubes, although both of these latter types are in the process of development.

Bronzes are used in impeller blades and to a degree for heavy duty bearings. Babbitts are used extensively for bearings.

Monel consists of about two parts of nickel to one of copper. One of its important uses was for turbine blades, and in this field it is still used, although a large proportion of the blades in modern turbines are made out of stainless iron.

Welding Grows More Popular

The use of welding in power-plant construction is receiving greatly increased attention. Engineers are yet fearful of poor welds and, unfortunately, no outstanding commercial method has been disclosed to date for the inspection of completed welds. However, improvements in the art are constantly being made, so that welds of today are greatly superior to those made five years ago. With this improvement it is believed that all forward-looking engineers will give greater consideration to the use of this method.

Little plating has been done for power-plant parts. This is an operation that will doubtless receive greater consideration in the future. A recent use of plating has been made by the Detroit Edison Company at the Trenton Channel plant in nickel-plating the stems of a number of important valves. A plating $\frac{3}{16}$ in. in thickness was put on the stem. As far as the writer knows this is the thickest plate that has been used commercially. Over six months of work was necessary in order to develop methods for performing this operation.

Chromium plating also offers possibilities, though it should be recognized that it has not worked out satisfactorily from the viewpoint of protecting metals against oxidation at elevated temperatures. This is undoubtedly due to the fact that most chromium plating is exceedingly thin and, in consequence, porous. The gases, therefore, have an opportunity to get through the chromium to the base metal. It is possible to thicken the chromium plate so as to avoid this condition, but so far as the writer is aware, this has not yet been done.

Nitriding produces a very hard surface on steel. It consists in subjecting steel containing special alloying elements such as aluminum, chromium, molybdenum, and vanadium to an atmosphere of ammonia at a temperature in the neighborhood of 950 deg. F. for from 12 to 90 hours.

One of the advantages of this process lies in the fact that the steel is heat-treated previous to the process and therefore no treatment is necessary afterward to give it hardness. This eliminates the warpage and scale often obtained in other methods of producing hard surfaces. Another advantage is the extremely hard surface obtained, estimated at 1,000 Brinell. Applications of this treatment have been made for the hardening of valve disks and seats.

Methods of Testing

A large number of types of tests are in use for the examination of the materials used in power plants. Some of the most important include tests to determine surface characteristics, tensile properties, hardness, metallographic characteristics, existence of blowholes and sand pits, strain and some others.

Most surface inspection is of a visual type. The use of the periscope in this connection is gaining in popularity for examining tubular sections, especially in the examination of such materials as condenser tubes, boiler tubes and the bore of turbine shafts.

The use of sulphur prints is increasing since these give indications of segregation, particularly of sulphides. In the case of large forgings sulphur prints are more and more used for the purpose of determining the chemical center of the metal, for it is obvious that in a mass of metal which is rotating at high speed less distortion and strain become manifest if the chemical and mechanical centers of the mass are in the same section.

Macroscopic examination by means of etched sections is growing in favor because it gives indication of segregation as well as flow lines which result from forging and other mechanical forming operations.

The method most commonly employed in the inspection of metals is the tensile test. This gives values for the proportional limit, elastic limit, yield point, maximum tensile strength, per cent elongation and per cent reduction of area. The proportional limit is usually accepted as that value at which the strain ceases to be proportional to the stress as obtained by plotted results. The elastic limit is likewise looked upon as that value at which the strain ceases to be proportional to the stress, although it is obtained by a release of the load and is the value secured when a strain just begins to manifest itself upon the release of the load. As a rule the elastic limit is somewhat higher than the proportional limit. The modern tendency is to favor the use of the proportional limit rather than the elastic limit.

Finding the Yield Point

The yield point is a rapid means of finding the load at which the strain ceases to be proportional to the stress. It is usually secured by means of the drop of the beam of the testing machine or the use of dividers employed for detecting a permanent set. It is the method most frequently used in commercial practice, though it gives values a few thousand pounds higher than do the proportional or elastic limits.

Impact tests of various types have been used for a number of years, but it is generally conceded that the methods of preparing test specimens for these tests play so great a part in the results obtained as to detract largely from the value of the test in ascertaining the quality of the material.

Hardness tests of various types are of value in measuring the hardness of metal. They provide a means of testing without destroying and are especially applicable for determining the quality of heat treatment done on parts such as nuts and bolts.

Metallographic methods, consisting of the examination of photomicrographs, are used extensively in the investigation of materials that have given difficulty in manufacture and use. They are valuable in determining the nature of the constituents, grain size, segregation, inclusions, strain, cavities and blowholes, decarburization, and cracks.

Magnetic Testing

Magnetic testing, although not yet used to any great extent, offers possibilities for being reliable in detecting defects in metals such as flow and interior flaws.

The X-ray examination of metals is used largely for the inspection of materials for blowholes and sand spots. The most notable use of this method was in the examination of the high-pressure castings for the Edgar Station. It is the writer's understanding that every one of these castings was examined by means of the X-ray and that a number of those initially presented for acceptance were rejected because the investigation revealed the presence of blowholes, sand spots and cracks in vital sections.

In view of the fact that the present X-ray equipment does not make it possible to examine sections much over

two inches in thickness, this method is subject to limitations. However, with the development of X-ray tubes of higher voltage it will be possible to examine thicker sections successfully.

Tests on Turbine Parts

In some cases it is possible to get some criterion of the amount of strain existing in the metal by actual stress measurements. This method was employed in the case of a disk from a turbine shaft which was examined in the "as received" condition, and in a similar disk after it had been annealed at 550 deg. F. for the purpose of relieving the stresses. The examination showed that the stresses in the disk of metal in the "as received" condition were of much greater magnitude than those existing in the disk after annealing.

A recent development in the examination of turbine shafts is what is known as "heat testing." This test consists in slowly rotating the turbine shaft in a heated chamber. Various temperatures have been employed, although at present most turbine shafts thus examined are heated to a temperature of approximately 752 deg. F. The deflection of the shaft throughout the heat cycle is noted, but greater emphasis is placed on the first and second cold readings. If the deflection from the first to the second cold reading is at any point in excess of 0.002 in., the acceptability of the shaft is questionable. Most shafts during the heat-test cycle show a movement greater than this 0.002 in., although the movement from cold to cold as previously stated, should not be in excess of it.

With the trend toward the use of higher operating temperatures in central stations, more information on the properties of metals at elevated temperatures is required, and not only should one have information with regard to properties of metals at elevated temperatures as determined by short time tests, but likewise information should be obtained with regard to the so-called "creep" characteristics.

The Field Is New and Much Remains to Be Done

Within the last few years a considerable amount of work has been done both in this country and abroad on this subject. The field, however, is so new and the number of alloys and the temperatures at which they should be examined are so great and the time required for a single creep test is so long, that the surface of this matter has hardly been scratched. These characteristics are being ably studied by joint committees sponsored by the American Society of Mechanical Engineers and the American Society for Testing Materials. Also, many laboratories have undertaken independent investigation on this subject.

The foregoing tests and methods of examination are by no means the only ones that may be employed in the inspection of metals for imperfections, defects and flaws. It is also recognized that the details given are extremely brief. This course was purposely followed in order to keep the paper within its reasonable limits, as it was the purpose to give a general bird's-eye of the field rather than to take up any one item in detail.

Welded Pressure Vessels

From a recent report of the Oxyacetylene Committee of the International Acetylene Association

DURING the last three years the progress of oxyacetylene welding in the construction of pressure vessels has been so broad and encouraging that we may justifiably say that this application has taken on an entirely different aspect during this period.

Prior to 1926 welding as applied to pressure vessels, for the most part if not entirely, was confined to units of comparatively small size and wall thickness fabricated from a single plate and designed on a very low fiber stress. Since that time, under procedure control guidance, limitations on size, wall thickness and design fiber stress have been altered outstandingly.

Over 200 welded pressure vessels in wall thicknesses up to 1¼ in., with diameters up to 90 in. and lengths up to 90 ft., and for working pressures up to 300 lb., have been constructed during the last three years under the writer's supervision alone. A typical example of this type of construction may be cited in the case of a creosoting unit recently fabricated throughout by oxyacetylene welding. This unit comprises the following equipment, all of which was designed for a fiber stress of 9,000 lb. per square inch:

Two Creosoting Retorts, 90 in. in diameter, 90 ft. long, 1-in. shell thickness, 200 lb. working pressure.

Three Pressure Measuring Tanks, 90-in. in diameter, 15 ft. 8 in. long, 1-in. shell thickness, 200 lb. working pressure.

One Reuping Tank, 90-in. in diameter, 55 ft. long, ⅛ in. shell thickness, 125 lb. working pressure.

Improvement in pressure-vessel design has played an important part in this recent development. Because of the high test pressure to which welded pressure vessels are subjected, points of high stress concentration and consequent weakness were discovered in designs previously considered entirely satisfactory for welded or other construction. As a result of these determinations improvements were made in design to eliminate these weak spots, particularly on heads and large openings. In the latter, furthermore, welding played an important part in the solution of the problem.

Hand in hand with these improvements came a greater confidence in the strength of the welded joint for pressure vessels and the initially adopted design fiber stress of 7,000 lb. per sq.in. was gradually increased to 9,000 lb. This latter figure has been used for some time by the writer in the design of all pressure vessels coming under his supervision.

Perhaps the outstanding progress made recently in this field of application, particularly with reference to the future developments, is the recognition that has been and is being given to welded pressure-vessel construction.

Several of the last and most reliable manufacturers of pressure-vessel equipment have developed methods and procedures for satisfactorily oxyacetylene welding practically all types and sizes of pressure vessels, regardless of shape and wall thickness. Insurance companies have agreed, furthermore, to insure such vessels if they are constructed in accordance with procedure-control methods.

Perhaps the recognition that will result in the greatest benefit to the progress of oxyacetylene welding in pressure-vessel construction is that which is being contemplated by the Boiler Code Committee of the American Society of Mechanical Engineers. This body, we understand, will in the not distant future place oxyacetylene welding on the same plane as hammer-welded construction. Such recognition by a body as necessarily conservative as the American Society of Mechanical Engineers will undoubtedly place the process in an exceedingly favorable position.

Injury on Hot Ashes

By A. L. H. Street

WHERE hot ashes from a power plant are dumped on the owner's premises upon which outsiders are expressly or impliedly invited to come, there is a duty on the part of such owner to use reasonable care to prevent injury to such persons through coming in contact with the ashes. This view is held by the New Jersey Supreme Court in the case of Roper vs. Commercial Fibre Company, 143 Atlantic Reporter, 741.

In this case the court affirmed a judgment in favor of a small child who was severely burned by dumped ashes while responding to an invitation posted by defendant company, inviting people to come and get ashes and boxes free. The youngster stepped on a pile of hot ashes while quite near a passageway which he was permitted to use. The court applied this general rule:

"The owner or occupier of lands, who, by invitation, express or implied, induces persons to come upon the premises, is under a duty to exercise ordinary care to render the premises reasonably safe for such purposes."

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Indiana Engineering Society Discusses Power Problems at Annual Meeting

Economics of Coal Industry, Changes in Boiler Rating Units, and Education of Plant Operatives Considered

THE Indiana Engineering Society held its Forty-ninth Annual Meeting at Indianapolis, in conjunction with the local A.I.E.E. and A.S.M.E. sections on Feb. 7 and 8. Out of a program consisting of fifteen papers there were several of interest to power men.

"Present Progress Toward Stabilization of the Coal Industry" was discussed by H. A. Glover, vice-president of the Knox Consolidated Coal Company. From 1917 on, the productive capacity of mines and miners increased much faster than the demand. The war and disturbances in the industry during the post-war period was responsible for this increase, whereas greater economies in utilization tended to hold down the demand, the speaker said. The result was 40 per cent excess capacity.

In 1924 deflation set in and many high-cost mines were abandoned. By 1927 the 9,331 bituminous mines of 1923 had shrunk in number to 7,011. This was accompanied by a reduction in the number of miners from 704,000 to 593,000 and by competition that brought about moderate wage reductions in certain sections. Also, disturbed labor conditions in the central competitive fields resulted in a shifting of business to the West Virginia and Kentucky fields.

Mr. Glover thought it unsafe to permit deflation in productive capacity to proceed too far lest the law of supply and demand again step in and cause an unwarranted price increase with its attendant evils. On the other hand, the operators are entitled to fair profits, which, in the speaker's opinion, could be brought about by consolidations. Thus, instead of abandoning good coal properties, they would be held in reserve and the active mines worked at better load factors.

Rating of Steam Boilers

Prof. H. L. Solberg, of Purdue University, pointed out the absurdities attending several of the prevalent ways of stating steam boiler performance. The term boiler horsepower is, of course, no longer used among engineers and is in fact a misnomer, although still used to some extent in the trade. Likewise, square feet of boiler heating surface now means little in view of the use of water walls, superheaters and economizers; and in consequence the expression "per cent of rating" is equally useless.

To illustrate this point the speaker threw on the screen sectional diagrams of two boilers, capable of producing about the same quantity of steam but with the heating surfaces differently distributed. That with the relatively small amount of actual boiler heating surface but having water walls, superheater and economizer, would be credited with a much higher per cent of rating than the other, in which most of the heat transfer surface was in the boiler proper, although the outputs might be the same.

Pounds of water evaporated per hour, while a convenient unit, does not give an accurate picture of performance because it does not tell anything about the efficiency or the feed-water temperature. The unit that Professor Solberg suggested as best suited to the purpose is thousands of heat units absorbed per hour by steam and water-heating surfaces. He would exclude the air preheater, as this heat goes back into the furnace to raise the temperature difference.

Training the Operator

"Education of the Power Plant Engineer" was the subject of an informal talk by Prof. A. W. Cole, of Purdue University, who has been doing extension-course work among power-plant operators for a number of years. The added complication of power-plant equipment makes careful selection and education of the operating men imperative. Both skilled and unskilled men are required in power-plant work and the training should be in accordance with these divisions, but every man should be made to feel the importance of his duties, however menial.

Educational work and training should be carried out on the job and on the company's time. Moreover, it is conducive to proper interest in the work and a spirit of co-operation to have operating executives occasionally attend the classes. Also, it is preferable to have much of the instruction come from men in the plant who can talk the same language as the operator.

A subject of great importance, but one seldom mentioned in such courses, is an explanation of the plant organization and the relation of each piece of apparatus to the whole.

Professor Cole praised the educational work of the N.A.P.E. and advised operating engineers to do more technical reading. He is also in favor of a state license law for Indiana.

Men in the News

J. SPOTTS McDOWELL

has been appointed Director of Research of the Harbison-Walker Refractories Company, Pittsburgh, Pa. Mr. McDowell has been connected with this company for some twenty years and is well known to the refractories and allied industries for his contributions to technical literature and his activities in the American Ceramic Society, American Society for Testing Materials, American Refractories Institute, and others.

Engineering Foundation to Sponsor Iron Research

RESEARCH in alloys of iron, to keep America abreast of world progress in industry, and described as the most ambitious undertaking ever attempted in this field, is planned by the Engineering Foundation in co-operation with the American Institute of Mining and Metallurgical Engineers, it has been announced at the national headquarters of the Foundation, 29 West 39th Street.

Industries, universities and technical schools, bureaus of the United States government, scientific organizations and foreign agencies will aid. Practically all industries, it is said, are affected. The initial task is a critical five-year review of all available literature in English and other languages,

resulting in a series of monographs and manuals, at a cost of $150,000.

Following a conference of representatives of makers and users of irons and steels, technical societies, government bureaus and universities, headed by J. V. W. Reynders, a Committee on Alloys of Iron Research has been appointed. The chairman is John Johnston, director of research and technology of the Unted States Steel Corporation. Other members of the committee are:

F. M. Becker, president of the Union Carbide and Carbon Research Laboratories; H. W. Gillett, chief of the Division of Metallurgy, United States Bureau of Standards; James T. MacKenzie, metallurgist and chief chemist of the American Cast Iron Pipe Company; and A. J. Wadhams, manager of research and development of the International Nickel Company.

"The future progress of the American iron and steel industry," says the Foundation's announcement, issued by Director Alfred D. Flinn, "will be greatly affected by its ability to maintain a strong position in alloy irons and steels. . . . Users and makers have acquired knowledge of iron from experience and research. A vast literature has accumulated, in many languages, marred by errors, disagreements and gaps. It contains much of value and rapidly increases in volume. It must be consulted, but lack of orderly arrangement, of classification, of evaluation, of accessibility and of generalization causes much waste of time and money. Facts are hidden from many persons who could use them profitably. Technical staffs and research men are aware of two needs, greater accessibility of existing knowledge and research for new knowledge.

The second phase of the program, which, it is expected, will extend over a long term of years, will be research directed toward increasing fundamental knowledge of iron and its combinations with other substances, particularly alloys of pure iron with one or two or three or more other pure metals; also the effects of the impurities incident to practical operations.

For other research in association with the enterprise, already under way, the Foundation has appropriated $10,000. At Lehigh University Prof. Bradley Stoughton is investigating combinations of silicum with iron. At the Carnegie Institute of Technology, Pittsburgh, Prof. V. N. Krivobok is studying combinations of manganese with iron.

Governor Roosevelt Accepts Plan To Divert Additional Niagara Water

Way Now Clear for Ratification of Treaty

AFTER obtaining from the Niagara Falls Power Company a stipulation conceding every claim advanced by the state regarding its rights in connection with the use of water from the Niagara River, Governor Roosevelt a few days ago assented to the treaty recently negotiated between the United States and Canada for preservation of the scenic beauty of the Falls.

The Governor expressed surprise that the negotiations concerning the diversion of additional water from the Niagara River should not have included representatives of New York State, since the construction necessary to this diversion will be on lands owned by the state. A report of the proposed diversion was given in a recent news section of *Power* at the time when the convention was signed between the United States and Canada. The Governor has made public a letter addressed by him to Senator Wagner of New York, conveying his acceptance of the plan. He said, in part:

"This convention is the result of careful study made by the international Niagara board, and this board worked out a plan under which an offer of the Hydro-Electric Power Commission of Ontario and the Niagara Falls Power Company, a private corporation of New York State, was recommended for acceptance.

"Under this offer the Ontario commission and the New York private corporation agreed to build the necessary weirs and structures in the bed of the river and asked in return the use, for a period of seven years, during the six winter months of each year, of 10,000 cubic feet per second of water on each side of the river.

"It is estimated that this 10,000 cubic feet per second on the American side would enable the Niagara Falls Power Company to develop between 80,000 and 100,000 horsepower.

" . . . I want to call your attention to the important fact that use of the 10,000 cubic feet per second proposed to be withdrawn depends on the consent of the State of New York to that withdrawal and to the satisfying of the State of New York that if it is withdrawn the people of the state are to receive an adequate rental for this water.

" . . . After a number of conferences I am glad to say that I have been able to obtain from the Niagara Falls Power Company a written stipulation, duly executed by it, which stipulation fully preserves the property rights and governmental authority of this state."

In the stipulation referred to, the power company agrees to pay a reasonable rental for the additional water used and to continue to pay rental for the water already in use, a payment which it has been making under protest for many years and which is at present the subject of litigation.

Spot * News

BOSTON *is following the lead of many other large cities in actively combating the smoke nuisance. The chamber of commerce of the Hub is doing some enthusiastic campaigning to obtain more smoke inspectors and to increase the number of convictions for infraction of the smoke ordinance. In the last eighteen years, the chamber's commitee says, two violators have been brought into court.*

* * *

ENGINEERING ECONOMICS *is the title of a course to be given by the Virginia Polytechnic Institute. The course has been started in answer to the need of a broader training for engineers, since 60 per cent of those graduating from the Institute eventually find their way into executive positions.*

* * *

FISH VERSUS POWER *is a question under discussion by the Federal Water Power Commission in connection with the proposed Rock Island development on the Columbia River. Similar cases in the past have been solved by the construction of bypasses around the dam so that the fish could get by on their way upstream. The Rock Island permit if granted will doubtless carry the same requirement.*

* * *

A LITTLE MORE *than seven million dollars is to be spent by the Montana Power Company during the current year, it is reported. More than half of this will go to enlargements on the Moreny plant on the Missouri River at Great Falls, Mont.*

* * *

DR. A. S. EDDINGTON, *of Cambridge University, has followed Professor Einstein's bewildering discovery with one equally bewildering concerning the electrical charge on the electron. The most intelligible feature of the discovery is the fact that the charge is expressed as a whole number, 136, instead of Dr. Millikan's 137.1. Thus it is seen that hair splitting among the charges on the electron is equivalent in importance to measuring the diameter of the universe by evaluating the curvature of space.*

* * *

NOT A SINGLE *hydro-electric plant is scheduled for completion on the West Coast during 1929. From Puget Sound to Tia Juana new construction is centered in steam, which, temporarily at least, will yield cheaper power than hydro.*

More Spot * News

APPLIED LIGHTNING *is the name which might be given to the high-voltage impulse tests which General Electric engineers are making in the Berkshire Hills with the artificial article perfected in the laboratory. They will thus be able to supply the shortcomings in nature's thunderstorm program, which have hitherto retarded experimental development of transmission line equipment.*

* * *

THE LAST GAP *in the electric power interconnection along the Atlantic seaboard from Bangor, Me., to Miami, Fla., has been closed with the completion of the Virginia Electric & Power Company's transmission line connection to the Virginia Public Service Company's network at Occoquan, Va.*

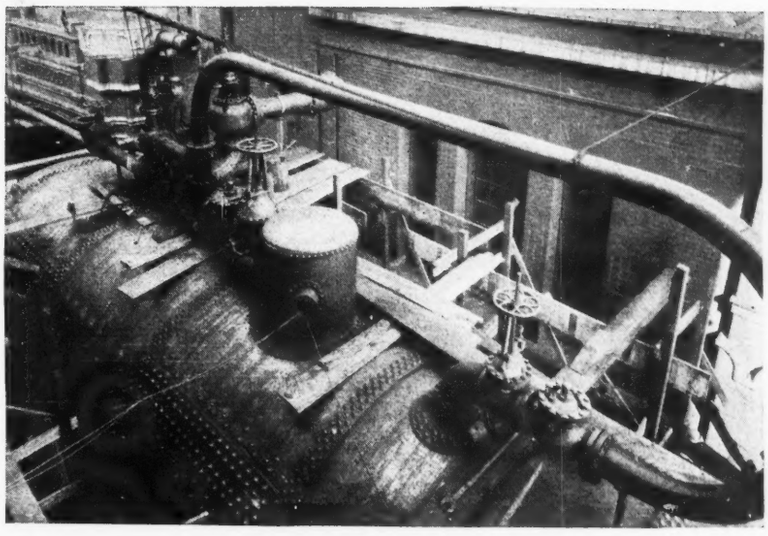
* * *

ATLAS-IMPERIAL DIESELS *can now be manufactured in double the former quantity, says president S. P. Eastman of the Atlas Company. Recent acquisition by this firm of the Pacific Diesel plant has made the new production schedule possible.*

* * *

BOULDER DAM PROPONENTS *are becoming nervous again, this time because certain states still refuse to ratify the recently passed bill. A threat to throw open the river to private development, it is hoped, will show the states the error of their ways and remove the last obstacle to the world's largest hydraulic development.*

* * *



RUTHS steam accumulator in process of installation at the new power plant of Anheuser-Busch, Incorporated, St. Louis, Mo. A high-pressure turbine installation will exhaust at 140 lb. pressure into the process steam mains, to which the accumulator will be connected.

Marine Engineers Hold Annual Meeting

The fifty-fourth annual convention of the National Marine Engineers Beneficial Association as held in Washington, D. C., Feb. 11 to 16, at the Hamilton Hotel. Delegates present represented sections in Buffalo, Cleveland, Detroit, Chicago, Baltimore, St. Louis, Portland, Me., Portland, Oregon, Milwaukee, Norfolk, New Orleans, Philadelphia, Jeffersonville, Ind., Point Pleasant, W. Va., Evansville, Ind., Pittsburgh, New York City, Toledo, Seattle, Galveston, Boston, New London, Grand Haven, Mich., Manitowoc, Wis., Duluth, Washington, D. C., and Balboa, Canal Zone.

William F. Yates was reelected president for two years. Other officers elected were D. W. Miller, first vice-president, William H. Hyman, second vice-president, Samuel Hogan, third vice-president, Albert L. Jones, secretary-treasurer. The convention also elected members of the executive committee representing districts as follows: William H. Hyman, Atlantic district; D. W. Miller, Pacific coast district; Samuel J. Hogan, Gulf coast district, William S. Brown, Great Lakes district; C. M. Sheplar, Western and Southern rivers district. All of the preceding were reelections except the third vice-president who replaced George Harrison, deceased.

Resolutions were adopted urging the enactment of legislation that would place Diesel-driven boats under the same rigid United States inspection laws as now apply to steamboats. It was voted to hold the next annual meeting in Detroit.

The National Marine Engineers Supply Men's Association met simultaneously. The following officers were elected: president, J. W. Aughiltree, Vacuum Oil Company; vice-president, J. W. Wilson, Dearborn Chemical Company; secretary-treasurer, Joe McKenna, Jenkins Brothers. Other organizations represented in this association were: Tidewater Oil Sales Corporation, Lunkenheimer Company, *Power*, Vacuum Oil Company, France Packing Company, Garrat-Callahan Company, Babcock & Wilcox Company, *American Marine Engineer*, and The Texas Company.

The annual banquet held Thursday night was attended by the supply men and friends in the various government departments, as well as by members of the association. A record for the association was made by Albert L. Jones, the secretary-treasurer, who attended the convention for the thirtieth consecutive year. Mr. Jones comes from Detroit.

Large Hydro Project in Arkansas

Construction of a second dam and hydro-electric plant on the Quachita River near Hot Springs, Ark., to cost $6,175,000 has been authorized by the board of directors of the Arkansas Power and Light Company and work on the new project will be started at once. The new barrier will be known as Carpenter Dam.

The dam will store water from a drainage area of 1,498 square miles and will create a lake 24 miles long and 10,000 acres in extent. The power plant will have an installed capacity of 40,000 kw., and be provided with two turbines of 20,000 kilowatts each.

Coal Explodes at Firestone Plant

A severe explosion of pulverized coal dust occurred in the preparation building of the Firestone Tire & Rubber Co., Akron, Ohio, on Wednesday Feb. 6 at 10:55 p.m. The force of the explosion was so great that it was felt for several blocks and every window in the building was blown out.

A thorough investigation has failed to fix the cause of the explosion positively, although it is generally believed that a spark or a hot coal from one of the boilers was responsible.

The men working in the building had noticed a small leak around one of the valves at the top of one of the

Coming Conventions

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester regional spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

Twelfth Exposition of Chemical Industries, New York City, May 6-11. For information address Publicity Department of the Exposition, Grand Central Palace, New York.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

collectors and it was here that the explosion occured. The valve was blown off from the top of the collector and the latter slightly damaged. There was no interruption of service in the power plant and a new valve was put in place and the collector was again in operation about five hours after the explosion. The factory schedule was not affected.

The building adjoins the boiler room and contains the crushers, pulverizing mills and collectors used in the preparation of the fuel. This pulverizing plant has been in use for about five years and this is the first accident worthy of mention which has happened during that time.

The total loss resulting from the explosion will amount to about $5,000. Men working in the building at the time reported a blinding flash followed by a terrific report. Stories of the explosion in local and outside newspapers were greatly exaggerated, one local report stating that the entire plant had been destroyed with several killed and about 50 injured. Actually two men were hurt, one seriously.

Obituary

John D. Curtis, one of the leading captains of industry of Worcester, Mass., and the first mechanical engineering graduate of the first class of Worcester Polytechnic Institute, died in that city Jan. 17. His first professional work was in connection with the salt marshes in Nevada. Mr. Curtis also was head draftsman in charge of plans for the Centennial Exhibition in Philadelphia in 1876.

Personals

T. Clyde Beatty has been transferred from the Chattanooga plant of the Hedges-Walsh-Weidner Company, to its New York City office at 200 Madison Avenue.

James M. Lyle, Jr., has left the employ of the Hedges-Walsh-Weidner Company, Chattanooga, Tenn., and has taken a position with the Henry Vogt Machine Company, of Louisville, Ky.

W. Neal Williams has left the employ of Sargent & Lundy, Chicago, Ill., and has accepted a position as mechanical engineer with the Management & Engineering Corporation, also of Chicago.

Garfield T. Allen has left the employ of the New York Power & Light Corporation, Albany, N. Y., and is now employed by the Edison Electric Illuminating Company of Boston in its generating department.

The Diesel Engine Users Association, London, England, has moved to 307 Abbey House, Westminster, and has appointed a new secretary in the person of Engineer Captain J. Hope Harrison, R. N.

Elmer L. Bassett, past-president, N.A.P.E., and until recently with the Hartford Works of the United States Rubber Company, has lately become associated with the Quigley Furnace Specialties Company, of New York City, in an engineering service capacity.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.25@$2.65
Kanawha.....	Columbus.....	1.25@1.60
Smokeless.....	Cincinnati.....	2.15@ 2.25
Smokeless.....	Chicago.....	2.15@ 2.25
S. E. Kentucky...	Chicago.....	1.30@ 1.60
Steam.....	Pittsburgh.....	1.50@ 1.75
Gas Slack.....	Pittsburgh.....	.90@ 1.10
Big Seam.....	Birmingham...	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2 85@$3.25
Barley.....	New York.....	1.30@ 1.75

FUEL OIL

New York—Feb. 14, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4⅜c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis—Feb. 8, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.45 per bbl. or 42 gal.; 26@28 deg., $1.50 per bbl.; 28@30 deg., $1.55 per bbl.; 30@32 deg., $1.60 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., distillate, 6c.

Pittsburgh—Feb. 11, f.o.b. local refinery, 30@34 deg., fuel oil 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Feb. 8, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati—Feb. 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Feb. 2, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c.@70c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.15 per bbl.

Boston—Feb. 11, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.5c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Feb. 9, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

With the Society Sections

A. S. M. E., Boston Section. Meeting, Feb. 27. Subject: "The Trend in Steam Power Station Design," by V. E. Alden, Stone & Webster Engineering Corp., Boston, Mass.

A. S. M. E., Knoxville Regional Meeting, Mar. 21-23, 1929. Technical program and trips to points of interest.

A. S. M. E., Philadelphia Section. Meeting Mar. 26. Subjects: "Resume of High Steam Pressures as Used in Industrial Plants," speaker to be announced later. "Twelve-hundred Pound Holland Station of the Pennsylvania and New Jersey Power System," by E. M. Gilbert, W. S. Barstow Management Association, Reading, Pa.

A. S. M. E., Toledo Section. Meeting Feb. 19. Subject: "Industrial Fuel-Fired Furnaces," by E. G. De Coriolois, Surface Combustion Co., Toledo, Ohio.

American Water Works Association, Montana Section. Annual convention, to be held April 4 and 5 at Great Falls, Mont.

American Water Works Association, Florida Section. Meeting, April 10, at Jacksonville, Fla. Subject to be announced later.

Louisiana Engineering Society. Monthly meeting, Feb. 25, at New Orleans. Subject: "Electric Welding of Steel Buildings," by F. P. McKibben.

Providence Engineering Society. Joint Meeting with A. S. M. E. and A. I. E. E. Sections, Feb. 19. Subject: "Some Applications of Economics to Engineering," by Dean Dexter F. Kimball, Cornell University.

Second Annual Indiana Fuel Conference, at Purdue University, Lafayette, Ind., April 4-5.

Business Notes

The American Electric Switch Corporation, Minerva, Ohio, has announced the appointment of Neil B.

Walsh as direct factory representative in western Pennsylvania, with headquarters in Pittsburgh. J. E. Cameron, manufacturers' agent, has also been secured to handle the American safety switch line in western Missouri and Kansas, with headquarters in Kansas City, Missouri.

PRESIDENT E. M. HERR announces that the Westinghouse Electric & Manufacturing Company has taken over the assets of the R. D. Nuttall Company as of Jan. 1, and will carry on the operations of the Nuttall company as a branch of the Westinghouse Electric & Manufacturing Company. The Nuttall plant will be known as the Nuttall Works of the Westinghouse Electric & Manufacturing Company and the product will be called Westinghouse-Nuttall.

THE DELTA-STAR ELECTRIC COMPANY, Chicago, and THE MONARCH ELECTRIC COMPANY, St. Johns, Quebec, Canada, have formed an association whereby the Canadian factory will now have full advantage of all Delta-Star designs, engineering and research facilities.

TRADE CATALOGS

PIPE THREADING MACHINE—A 20-page booklet has been issued by the Curtis & Curtis Company, Bridgeport, Conn., illustrating its new pipe cutting and threading machine. The booklet contains many photographs of the machine in operation, pictures of various models and tables of dimensions, capacities, cutting speeds, etc.

SMALL MOTORS—The Wagner Electric Corporation, St. Louis, Mo., has issued a 4-page bulletin No. 158 describing its line of small vertical motors of $\frac{1}{8}$ to $1\frac{1}{2}$ hp., direct- and alternating-current types. The bulletin contains some interesting diagrams and sketches of bearing construction.

WELDING RODS—The Chicago Steel & Wire Company, Chicago, Ill., has issued a 4-page descriptive leaflet covering its "Weldite" line of welding rods for both gas and electric welding. The leaflet gives specifications for all types of welding rods.

NICKEL STEEL—In an 8-page bulletin No. 13 the International Nickel Co., Inc., New York City, presents an article by P. H. Wickenden, of that company, on corrosion, impact and other mechanical properties of nickel-chrome steel. Curves and other data are included.

LIGNITE—In an 8-page leaflet issued by the Combustion Engineering Corporation, New York City, the subject of lignite as a commercial fuel is discussed by E. P. Price. This paper is reprinted from the N.E.L.A. bulletin of September, 1928, and covers the subject of lignite as used in Texas.

FITTINGS — The Duriron Company, Dayton, Ohio, has issued price list No. 14 effective Jan. 1. This list includes valves, cocks, flanges, steam jets and other equipment.

FLUE-GAS ANALYZER—Bulletin AA-29 issued by the Hayes Corporation, Michigan City, Ind., is a 16-page treatment of its flue-gas analysis equipment. The publication is profusely illustrated with pictures of the equipment and its applications.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

California—Coast Counties Gas & Electric Co., Russ Bldg., San Francisco, plans to expend $485,000 for extensions and improvements to gas mains and electric systems in Santa Cruz, Watsonville, Gilroy, Hollister and Pittsburgh.

Calif., Long Beach — Pacific Electric Railway Co., Pacific Electric Bldg., Los Angeles, is having plans prepared for the construction of an electric sub-station, etc. at Morgan Ave. Yard here. Private plans.

Calif., Los Angeles—City awarded contract for the construction of a pumping plant in connection with Section 5, Venice Outfall Sewer to Carpenter Bros., 457 North Canyon Dr., Beverly Hills. Estimated cost $112,654.

Calif., Patton—State received lowest bid for the construction of a kitchen and cold storage plant at State Hospital here, from J. Strona, East End Ave., Chino. $63,800. Refrigeration machinery and equipment, etc. will be furnished by the state.

Calif., San Francisco—Bellaire Building, Inc., Crocker First National Bank Bldg., will soon receive bids for the construction of a 23 story apartment building at Green and Leavenworth Sts. Estimated cost $700,000. H. C. Baumann, 251 Kearny St., is architect. L. H. Nichkian, 525 Market St., is engineer.

Calif., Santa Barbara—Cottage Hospital, is having plans prepared for the construction of a 4 story addition to hospital including steam heating system, elevators, etc. at Third and Bath Sts. Estimated cost $500,000. C. M. Winslow, 1001 Architects Bldg., Los Angeles, is architect.

D. C., Anacostia (br. Washington) — U. S. Government, Dept. of Interior, W. B. Acker, Washington, will soon receive bids for the construction of a hospital here. Estimated cost $785,000.

D. C., Washington — Sears-Roebuck & Co., Arthington and Homan Sts., Chicago, Ill., are having tentative sketches made for the construction of a department store and warehouse on Bladensburg Rd. N. E., here. Estimated cost $500,000. Nimmons, Carr, Wright, 333 North Michigan Ave., Chicago, are architects. M. Schwab, 30 North Michigan Ave., Chicago, is engineer.

Ill., Chicago—I. Flam, 105 West Adams St., is receiving bids for the construction of a group of apartment buildings including ventilation and electric refrigeration systems, etc., at North Hoyne and Granville Aves. Estimated cost $1,000,000. A. L. Himelblau, 30 North Dearborn St., is architect.

Ill., Chicago—P. F. Olsen Inc., 20 Cass St., Archt. will receive bids about Mar. 5 for the construction of two 8 story apartment buildings including central refrigeration plant, elevators, etc. at Cyril Ave. and 71st Pl. for Syndicate, c/o architect. Estimated cost $1,000,000.

Ill., Chicago — Presbyterian Theological Seminary, 2330 North Holsted St., plans to expend $3,000,000 for construction program to extend over a period of 5 years. Plans include fourteen college buildings, power plant, etc. Contract for the erection of the gymnasium awarded.

Kan., Kansas City—City is having plans prepared for the construction of a municipal electric light plant. Estimated cost $400,000. A. L. Mullergren, Bd. of Trade Bldg., Kansas City, Mo., is engineer.

La., Monroe—City is having plans prepared for the construction of a pumping station and dam 50 ft. high and 20 ft. wide at Bayou De Siard. M. P. Hatcher, Monroe, is engineer.

La., Winnfield—City, H. T. Willis, Clk, will receive bids about Feb. 26 for the construction of a water and light plant, also 22 miles of electric transmission lines. Estimated cost $125,000. Swanson-McGraw Inc., Balter Bldg., New Orleans, is engineer.

Me., Bangor—Bangor Hydro Electric Co., Harlow St., had plans prepared for the construction of a 75 x 90 ft., additional unit to plant. F. A. Patterson, 16 Central St., is engineer.

Md., Baltimore—Asiatic Petroleum Co. of New York, Ltd., 65 Broadway, New York, awarded contract for the construction of an office building and boiler house here, to C. W. Schmidt, Hearst Tower, Baltimore.

Md., College Park—University of Maryland, plans the construction of a central heating plant. Estimated cost $200,000. Smith & May, Calvert Bldg., are engineers.

Mass., Dedham—Fisher Churchill Co., is receiving bids for the construction of an artificial ice plant. P. A. Hopkins, 45 Bromfield St., Boston, is engineer.

Mass., Everett—Edison Electric Illuminating Co., 39 Boylston St., Boston, is having tentative plans prepared for the construction of a power generating plant here. Engineer not selected.

Michigan—Consumers Power Co., C. W. Tippy, V. Pres. and Gen. Mgr., Jackson, plans to expend $18,000,000 for improvements and construction work during 1929. Plans include new office buildings and equipment, new boiler; 26,000 hp. turbine at Wealthy St., Grand Rapids, two generators at Saginaw steam plant, 600 hp. generator at Lyons water plant, transformers; construction improvement Gas Dept., office at Battle Creek, service buildings at Flint, Kalamazoo and complete buildings at Flint and Royal Oak.

Mich., Detroit—Grace Hospital, W. L. Babcock, Grace Hospital, plans the construction of a 4 story addition to hospital including steam heating and ventilation systems, etc. on John R. St. Estimated cost $1,850,000. Architect not announced.

Mich., Detroit—Michigan Bell Telephone Co., 1365 Cass Ave., is having plans prepared for the construction of a telephone exchange and office building, including steam heating system, boilers, etc., at Six Mile Rd. and Stoepel St. Estimated cost $50,000. Smith, Hinchman & Grylls, 800 Marquette Bldg., are architects.

Mich., Muskegon—City is having plans prepared for the construction of a sewage disposal plant and pumping station. Estimated cost $150,000. Hoad-Decker-Shoecraft & Drury, Ann Arbor, are engineers.

Minn., Winona—Bd. of Public Works, O. Leicht, Pres., plans the construction of an electric pumping station. Estimated cost $55,000. Engineer not selected.

Miss., Ellaville—Mississippi School and Colony for Feeble Minded, c/o Mississippi Building Commission, W. C. Trotter, Secy., Jackson, will receive bids until Mar. 7 for the construction of a hospital including 12 x 12 ft. pump house, 52 x 62 ft. power house, etc. here. Estimated cost $300,000. C. H. Lindsley, Lamar Life Bldg., Jackson, is architect.

Miss., Oxford—University of Mississippi, c/o Mississippi State Building Commission, W. C. Trotter, Secy., Jackson, awarded contract for the construction of a group of college buildings including pump house, etc. here to Sandquist & Snow, Alexandria, La. Estimated cost $310,514.

Mo., St. Louis—Bd. of Education, 911 Locust St., is having preliminary plans prepared for the construction of a high school including steam heating system, etc. at Hampton and Penrod Aves. Estimated cost $1,000,000. R. M. Milligan, c/o Bd. of Education, is architect and engineer.

Neb., Coleridge—City is having preliminary plans prepared for the construction of a sewage disposal plant including pumping station, etc. $43,301. Henningson Engineering Co., 326 Union State Bank Bldg., Omaha, is engineer.

Neb., Glenvil—City, J. J. Mohlman, Clk., will receive bids until Mar. 1 for waterworks and distribution systems, including well, pump house, tank on tower, etc. Estimated cost $20,850. Nixon & Reynolds, Grain Exchange Bldg., Omaha, are engineers.

N. J., Elizabeth—W. Clifford, Jr., 293 Morris Ave., Archt., will receive bids about Mar. 1 for the construction of an ice plant at Elizabeth River and South 7th St., for Kruman & Burnstein, c/o architect. Estimated cost $50,000.

N. J., Newark—Knickerbocker Ice Co., 41 East 42nd St., New York, N. Y., awarded contract for the construction of an ice plant at 136 Rose St., to Waldemar Mortensen Inc., 103 Park Ave., New York, N. Y. Estimated cost $40,000.

N. J., Newark—National Newark & Essex Banking Co., C. L. Farrell, Pres., 752 Broad St., is having preliminary plans prepared for the construction of a 32 story office building including steam heating and ventilation systems, elevators, etc. at Broad, Commerce and Clinton Sts. Estimated cost $10,000,000. J. H. and W. C. Ely, 605 Broad St., are architects.

N. J., Newark—United States Realty & Investment Co., W. E. Lehman, Pres., 972 Broad St., is having preliminary plans prepared for the construction of a 15 story office building including steam heating system, etc. at Broad and Bridge Sts. Estimated cost $1,500,000.

N. J., Pinewald—Helmle & Corbett, 132 West 42nd St., New York, Archts., will receive bids about Feb. 14 for the construction of an 8 story hotel, including steam heating, ventilation and refrigeration systems, boilers, elevators, etc., for Sangor Hotel Corp. Estimated cost $1,500,000.

N. Y., New York—Jerrold Holding Corp., P. Uris, Pres., 271 Madison Ave., plans the construction of a 22 story hotel at 250 West 43rd St. Estimated cost $2,400,000. E. Roth, 1440 Broadway, is architect.

N. Y., New York — Jewish Maternity Hospital, c/o N. Ralnoff, 1192 Park Ave., plans the construction of a 15 story hotel at 5th Ave. and 108th St. Architect not selected.

O., Apple Creek—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, is having revised plans prepared for the construction of a power house, etc., for Institutions of Feeble Minded, here. Estimated cost $56,000.

O., Canfield—Commissioners of Mahoning County, Youngstown, is having plans prepared for extending waterworks of city of Youngstown to here, including feed line from Boardman to Canfield, booster plant at Stan Corners, etc. Estimated cost $100,000.

O., Cleveland — Cleveland Electric Illuminating Co., W. H. Hartman, Pres., Illuminating Bldg., awarded contract for the construction of an electric sub-station on Canal Rd., to Hunkin-Conkey Construction Co., Newman-Stern Bldg. Estimated cost $325,000.

O., Cleveland — Liquid Carbonic Corp., 3100 South Kedzie Ave., Chicago, Ill., awarded contract for the construction of a 90 x 200 ft. ice plant at West 58th St. and Herman Ave., here, to H. K. Ferguson Co., Hanna Bldg., Cleveland. Estimated cost $150,000.

O., Orville—Bd. of Public Affairs, A. D. Webster, Supt., plans addition to boiler house for municipal light plant. Estimated cost $50,000. Hadlow, Hughes, Hick & Conrad, Inc., 850 Euclid Ave., Cleveland, are engineers.

Ore., Medford—Southern Oregon Sales Co. is having plans prepared for the construction of a storage, packing and precooling plant. Estimated cost $150,000. L. B. Humphreys is architect.

Pa., Philadelphia—S. T. Hall, 1708 Sansom St., awarded contract for the construction of a 13 story office building to Wark Co., 1600 Walnut St.

Pa., Pittsburgh—Webster Hall Corp., P. A. Miller. plans the construction of an 8 story hotel on Dithridge St. Estimated cost $750,000. C. N. Agrie, 1140 Bork Tower Bldg., Detroit, Mich., is architect.

R. I., Pawtucket—Pawtucket Ice Co., H. L. Russell, 126 Main St., is receiving bids for the construction of an artificial ice plant. R. E. Palmer, 58 Suffolk St., Holyoke, is architect. York Ice Machinery Corp., 200 Causeway St., Boston, is engineer.

Tex., Cameron—Cameron County Water Improvement Dist. 14, c/o R. G. Ransom, Brownsville, plans the construction of an irrigation project to include pumping plant at El Jardin tract, a secondary pumping plant at Boyd tract, etc. Estimated cost $1,250,000. W. E. Anderson, San Benito, is engineer.

Tex., Eagle Pass — Maverick County Water Improvement Dist. 1, voted $1,800,000 bonds for the construction of hydroelectric power plant in connection with gravity irrigation system. Private plans.

Tex., Elsa—Central Power & Light Co., F. C. Ludden, Dist. Mgr., San Benito, awarded contract for the construction of a cold storage plant, 200 ton capacity to Sumner Sollitt Co., Frost Bldg., San Antonio.

W. Va., Elkins—City plans an election Mar. 5 to vote $135,000 bonds for the construction of a municipal power plant. G. W. Wilson, mayor.

Ont., Toronto—Yolles & Rotenberg, Federal Bldg., is having plans prepared for the construction of a 25 story office building including steam heating system, elevators, etc. Estimated cost $1,000,000. Chapman & Oxley, Sterling Tower Bldg., are architects.

Ont., Windsor — Bell Telephone Co. of Canada, Notre Dame St., Montreal, Que., plans the construction of a 6 story, telephone office building and exchange including steam heating system, elevators, etc. at Goyeau St. Estimated cost $700,000. J. J. McNab, 18 Hospital St., Montreal, Que., is architect.

Equipment Wanted

Boilers, Pumping Units, etc. — City of Dallas, Tex., will receive bids until Mar. 15 for steam boilers, motor pumping units, switchboard and control, steam turbine pumping units, turbo generators, etc., for proposed waterworks improvements.

Bucket Conveyor—North Cambridge Coal Co., 44 Whittemore Ave., North Cambridge, Mass., is in the market for a bucket conveyor for unloading coal.

Electric Motors, Transformers, etc.—A. L. Flint, Purchasing Officer of the Panama Canal, Washington, D. C., will receive bids until Mar. 2 for electric motors, transformers, water pump, switchboard, etc.

Generator Plants — Dept. of Commerce, Division of Supplies, Washington, D. C., will receive bids until Feb. 25, for fifty engine generator plants, 2¼ kw. capacity each.

Motors—Wilmington Packing Co., Wilmington, Mass., is in the market for two 25 hp. G. E. electric motors, 3 ph., 440 v., etc.

Pumping Equipment — City of Weimer, Tex., pumping equipment for proposed waterworks improvements. Estimated cost $50,000.

Pumping Equipment — J. F. Donovan, City Mgr., Auburn, N. Y., will receive bids until Mar. 12 for pumping equipment including one 10 m.g.p.d. centrifugal pump, two 5 m.g.p.d. centrifugal pumps and one 2½ m.g.p.d. centrifugal pump all direct connected to slip ring motors

Refrigeration Equipment—Dept. of Mental Hygiene, Albany, N. Y., will receive bids until Mar. 13 for refrigeration equipment, etc., for Utica State Hospital, Marcy Division, Marcy, N. Y.

Regulators—Dept. of Public Works, Supplies & Tenders Committee, Wellington, N. J., will receive bids until Apr. 9 for two outdoor type automatic induction voltage regulators.

Industrial Projects

Ala., Bessemer — CAR MANUFACTURING PLANT—Pullman Car & Mfg. Corp., 79 East Adams St., Chicago, Ill., awarded contract for the construction of a 200 x 1,500 and 150 x 1,200 ft. car manufacturing plant here to United Engineering & Construction Co., 112 North Broad St., Philadelphia, Pa. Estimated cost $3,000,000.

Ala., Gadsden — RUBBER FACTORY and POWER HOUSE—Goodyear Tire & Rubber Co., East Market St., Akron, O., awarded contract for the construction of first unit of rubber factory with exception of power house here, to A. K. Adams & Co., 542 Plum St. N. W., Atlanta, Ga. Estimated cost approximately $800,000.

Calif., Los Angeles — TIRE and RUBBER FACTORY and BOILER PLANT — Samson Tire & Rubber Corp., 733 East 8th St., awarded contract for the construction of a 265 x 1,350 ft. factory to include boiler plant, pump house, etc., to McNeil Co., 5860 Avalon Blvd. Estimated cost $1,000,000.

Conn., Hartford — GOLD LEAF FACTORY and BOILER HOUSE—M. Swift & Sons, 100 Love Lane, will soon award contract for the construction of a 2 story, 55 x 175, 24 x 40 and 20 x 50 ft. factory, including boiler house. Estimated cost $100,000. Mylchreest & Reynolds, 238 Palm St., are architects.

Ga., Thomaston — RUBBER FACTORY and BOILER PLANT — B. F. Goodrich Rubber Co., Main St., Akron, O., will soon award contract for the construction of a 3 story, 135 x 1,100 ft. factory to include 2 story, 120 x 450 ft. picker and raw cotton storage buildings, 40 x 70 ft. boiler plant, etc., here. Rober & Co., Bona Allen Bldg., Atlanta, Ga., are architects and engineers.

Mass., Lynn—DIE CUTTING FACTORY AND POWER AND TRANSFORMER STATIONS—North Shore Cutting & Die Co., 266 Broad St., is receiving bids for the construction of a 1 story factory including power house and transformer house on Broad St. B. E. Porter, 75 Tremont St., Boston, is architect.

Mich., Detroit—MACHINE SHOP—Ex-Cell-O Tool & Mfg. Co., 1200 Oakman Blvd., awarded contract for the construction of a 1 story machine shop to Austin Co., General Motors Bldg. Estimated cost $50,000. Electric motors and miscellaneous equipment will be installed.

N. J., Camden—FOUNDRY, ENAMELING BUILDING AND POWER HOUSE—Rundle Mfg. Co., 27th St. and Cleveland Ave., Milwaukee, Wis., had plans prepared for the construction of a 150 x 330 ft. foundry, 100 x 180 ft. enameling plant, 120 x 180 ft. warehouse and shipping building, power house and heating plant, motor driven compressors, etc. here. Estimated cost $1,000,000. A. A. Wickland & Co., 205 West Wacker Dr., Chicago, Ill. are architects.

N. J., Kearny—INSULATION FACTORY—Zenithern Co., 390 Frelinghuysen Ave., Newark, awarded contract for 1 and 3 story, 82 x 442 ft. factory on Harrison Ave. to R. Allen Inc., 319 Mount Pleasant Ave., Newark. Estimated cost $250,000.

O., Canton—TUBE PLANT—Timken Roller Bearing Co., Dueber Ave., awarded contract for a 1 story, 320 x 450 ft. tube plant to Hiner Steel Co., Second St. N.W. Estimated cost $200,000.

O., Cleveland — AXLE and SPRING FACTORY—Eaton Axle & Spring Co., C. J. Ochs, pres., East 65th St. and Central Ave., awarded contract for a 1 story, 51 x 130 ft. factory at East 69th St. and Central Ave., to S. W. Emerson Co., 1836 Euclid Ave. Estimated cost $40,000.

O., Toledo—GLASS FACTORY—Libbey-Owens Sheet Glass Co., Nicholas Bldg., awarded contract for the construction of a glass factory on East Toledo St. to A. Bentley & Sons, Balmont St. Estimated cost $4,000,000.

Ont., Hamilton—YARN MILL—Hamilton Cotton Co., 304 Mary St., is having plans prepared for the construction of a yarn mill on Main St. W. Estimated cost $500,000. B. H. & F. Prack, Pigott Bldg., are architects.

Ont., Toronto—SIGN FACTORY—Day Name Plates Ltd, 4 Woodfield Rd., is having plans prepared for the construction of a 2 or 3 story sign factory. Estimated cost $50,000. Chapman & Oxley, Sterling Tower Bldg., are architects.